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Combustion and Perfomance Testing of OX-CE Coal Water Fuel at The Chatham N.B. Generating Station

Final Report

Project Manager
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The New Brunswick Electric Power Commission

Energy Mines and Resources Canada

MICROMEDIA

DATE: MAY 1986

DSS FILE Nº 15SQ-23440-4-9299

DDS CONTRACT SERIAL Nº OSQ85-00013

CANMET SCIENTIFIC AUTHORITY Dr. H. WHALEY

161 pp

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TITLE: Combustion and Performance Testing of OX-CE Coal Water Fuel at the Chatham N.B. Generating Station.

FINAL REPORT - VOLUME I

PROJECT MANAGER

D.M. RANKIN

Work on the Project was conducted under the auspices of the Canada Center for Mineral and Energy Technology, Energy, Mines and Resources Canada.

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FINAL REPORT

FOR

THE OX-CE FUEL DEMONSTRATION

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1.0 EXECUTIVE SUMMARY

The objective of this coal-water fuel demonstration was to evaluate the combustion of OX-CE coal-water fuel in the two boilers (front fired and corner fired) at the New Brunswick Electric Power Commission's Chatham Thermal Generating Plant.

The coal-water fuel was supplied free of charge by the OX-CE Fuel Company of Windsor, Connecticut, U.S.A., from their Jacksonville, Florida plant and the project was responsible for all other costs including the transportation of the coal-water fuel from Jacksonville, Florida, to Chatham, N.B.

The OX-CE fuel was originally manufactured in the Fall of 1984 and had been reprocessed in the Spring of 1985. The fuel was transported to Chatham in June 1985.

Combustion Engineering Canada Ltd. and CE Power Systems of Windsor, Connecticut, modified the burners in the corner fired boiler based on experience obtained from the previous test programs.

Commencement of the testing was delayed because the new CE burners were not ready until late July by which time the fuel had begun to settle. With the assistance of the OX-CE Fuel Company, the fuel was rehabilitated to a state where it could be burned with stable fires in either boiler with some support from heavy fuel oil burners.

In late July 1985, the modified burners were tested using Carbogel coal-water fuel so that the effect of the modifications to the burners could be evaluated using a fuel that was similar to that used for the original burner development work.

Unit No.1 (the front fired unit) was operated on rehabilitated OX-CE fuel and bright stable fires were achieved with pilots in operation and oil burners in adjacent ports.

Unit No.2 (the corner fired unit) operated on rehabilitated OX-CE fuel giving bright, stable fires, with no pilots in operation and only one oil burner in service at half load.

A fly ash sample taken from the mechanical dust collectors had about 60% combustibles in it. The ash in the original fuel was approximately 6.0% (dry).

The CWF firing rate on the unit was limited by flue gas opacity exiting the chimney. In general, the OX-CE fuel burned very similar to the CBDC Carbogel and was quite easily rehabilitated with additives and simple mixing.

An efficient fly ash particulate collector is required when burning any type of coal-water fuel.

1.0 SOMMAIRE

L'objectif de cette démonstration du combustible charbon-eau était pour l'évaluation de la combustion du combustible charbon-eau (OX-CE) dans les deux chaudières (feux-de-murs 'front fired'), feux-de-coins (corner fired) à la station thermique de Chatham, Energie Nouveau-Brunswick.

Le combustible charbon-eau nous a été supplié sans frais par la compagnie de combustible OX-CE de Windsor, Connecticut, E.U. Ils ont fourni le combustible (OX-CE) de leur usine à Jacksonville, Floride. Tous les autres coûts comprenant les frais de transportation du combustible charbon-eau de Jacksonville, Floride à Chatham N.B. ont été absorbé par le projet.

Le combustible OX-CE a été originalement préparé à l'automne, 1984 et a été re procédé au printemps de 1985. Le combustible a été transporté à Chatham au mois de juin, 1985.

La compagnie Combustion Engineering Canada Ltd. et CE Power Systems de Windsor, Conneticut ont modifié les brûleurs dans les chaudières (feux de coins, 'corner fired') basés sur des développements d'essais précédents.

Les essais ont subi un délai dû au fait que les brûleurs de Combustion Engineering n'étaient pas prêts jusqu'à la fin de juillet et pendant ce temps le combustible commençait à s'établir. Avec l'assistance de la compagnie OX-CE, le combustible a été reconditionné à l'état où il pourrait brûlé à feux stables dans n'importe quelle chaudière avec le support des brûleurs du combustible le mazout lourd.

A la fin de juillet 1985, les brûleurs modifiés on été mis à l'essai se servant du combustible Carbogel (Charbon-eau) en raison que l'effet de la modification aux brûleurs pourrait mieux être évalué se servant d'un combustible qui était semblable à celui servit pendant le développement original des brûleurs.

Unité No.1 (feux-de-murs 'front fired') a été opéré avec le combustible OX-CE (reconditionné) résultant des feux stables, brillants avec les allumeurs en opération et les brûleurs de mazout dans les ports adjacents.

Unité No.2 (feux-de-coins 'corner fired') a été opéré avec le combustible OX-CE (reconditionné) résultant des feux stables et brillants sans avoir les allumeurs en opération et se servant de seulement un brûleur de mazout à demi capacité.

Des échantillions de cendres ont été extrais des collecteurs de poussière méchanique (cyclones). Les échantillions étaient composés d'à peu près 60% de combustibles. Les cendres du combustible original étaient approximativement 6% (sec).

1.0 SOMMAIRE (SUITE)

Le taux de brûlage du combustible charbon-eau dans l'unité était limité dû à l'opacité des gaz émanant sortant de la cheminée. En générale, le combustible OX-CE a brûlé très semblablement au combustible CB DC Carbogel et l'OX-CE a été facilement reconditionné avec des additifs et par la simplicité de mélanger.

Un collecteur de cendres très efficace est nécéssaire quand on brûle n'importe quelle sorte de combustible charbon-eau.

2.0 INTRODUCTION

The Department of Energy, Mines and Resources has identified coal-water fuels technology development as a priority. The potential for the fuel relates to oil substitution in boilers and furnaces not designed for conventional pulverized coal combustion. Under the special Atlantic Initiatives, funding is being provided to develop burners to burn coal-water fuel and to demonstrate the combustion performance of the fuel in the two utility boilers at Chatham, N.B. In its role of technology support to this demonstration, the Canada Centre for Minerals and Energy Technology (CANMET) has been involved in development of CWF burners through the Chatham Utility Boiler Demonstration Project.

The earlier projects had shown that burner performance at the present stage of development is very dependent on fuel quality. In order to assess the CWF burners installed in Chatham Units 1 and 2, it was the intention of this demonstration to evaluate one other commercially available CWF. The fuel used for this demonstration was supplied from the U.S. and was provided gratis by the manufacturer. This provided valuable comparative performance data with the CBDC/Carbogel-CWF burnt in both units at the Chatham Plant.

3.0 BACKGROUND

In April 1982, an agreement was signed between Energy Mines and Resources, N.B.Power and the Cape Breton Development Corporation which resulted in the construction of a coal-water fuel production plant at Sydney, Nova Scotia; and using the product from this plant, testing of prototype coal-water fuel burners has been carried out at the Chatham Generating Station in New Brunswick.

The results achieved from these tests have been encouraging and is supportive of the continued research and development of coal-water fuels as a substitute fuel in existing oil fired boilers.

Coal-water fuel demonstrations are being investigated for oil fired utility boilers up to 100 MWe rating.

Currently there are a number of available coal-water fuels.

4.0 LIST OF PARTICIPANTS

- New Brunswick Electric Power Commission (provided the Plant)
- CANMET, Energy Research Laboratories, Department of Energy Mines and Resources Canada (the Scientific Authority)
- OX-CE Fuel Company Limited (coal-water fuel supplier)
- Combustion Engineering Superheater Limited (modified burners at their cost on Unit No.2 boiler)
- National Research Council of Canada (provided burner/atomizers for Unit No.1)
- Research and Productivity Council (New Brunswick) (conducted ash analysis)

5.0 WORK DESCRIPTION

The work plan for this demonstration involved:

- The modification of the burners and atomizers for the Unit No. 2 boiler.
- Testing of the coal-water fuel supplied by OX-CE Fuel Company.
- The results obtained were compared with results obtained on previous demonstrations using Carbogel fuel.
- Testing of the modified burners in the Unit No. 2 with Carbogel CWF.
- Also included in this demonstration was a test burn in the Unit No. 1 boiler, using OXCE fuel.

5.1 Sequence of Events

April 1985	-	Unit No.2 out of service while C.E. Canada/KDL rebuilt their burners and atomizer.
June 25/85	-	KDL on site to check the Unit No.2 ignitors.
		Six rail cars of OX-CE fuel (CWF) shipped from Jacksonville, Florida.
July 15/85	-	CE/KDL on site to install their modified burner and atomizers.
July 16/85	-	OX-CE fuel (CWF) arrived in Chatham/Newcastle area.
July 20/85	-	CWF burner front supply pumps relocated.
July 23/85	-	Unit No.2 boiler ready but the new C.E. atomizer tips did not arrive in Chatham until late on July 23.

July 24/85	-	Unit No.2 unavailable because of boiler feed pump problems.
July 25/85	-	Boiler feed pump repair completed but Unit No.2 could not be in service before 6:00 p.m. because of a lack of demineralized water.
July 26/85	-	More testing done on one modified CWF gun.
	-	CE and KDL people left site.
Aug. 6/85	-	Unit No. 2 on line to burn the carbogel (CWF) in the bunker.
Aug. 7/85	-	The water level in the Unit No. 2 boiler drum went too high, which allowed wet steam to go to the turbine, and the unit tripped.
Aug. 12/85	-	Inspection of turbine completed - the unit will be out of service for 4 weeks.
Aug. 29/85	-	62.4 tons of OX-CE fuel unloaded from one rail tank car.
		12 to 18 inches of settled CWF remained in the bottom of the car. Water was added and with the use of compressed air lances, the product was off-loaded.
Aug. 30/85	-	24.6 tons of OX-CE fuel burned in Unit No. 1.
Sept. 6/85	-	Remainder of OX-CE fuel in the bunker burned in Unit No. 1.
Sept. 9/85	-	Agreed with OX-CE - their fuel will have to be replaced before a meaningful test can be conducted in Unit No. 2.
Sept.11/85	-	Second car of OX-CE fuel being unloaded.
Sept.12/85	-	Unit No.1 out of service while the cooling water channel was being inspected.
Sept.16/85	-	Unit No.1 in service burning OX-CE fuel.
Sept.17/85	-	Unit No.1 out of service because the power supply to the tank farm was cut accidently by the Unit No.3 construction.
		3 empty rail cars released for return to OX-CE.
Sept.18/85	-	Unit No.1 still out of service.
Sept.20/85	-	Unit No.1 in service for a short time but had to be shut down because of weather.

	-	Dispersion of the flue gas was not possible because of atmospheric inversions.
Sept.25/85	-	Unit No.2 boiler was in service to dry out the new insulation on the turbine but later had to be shut down due to a boiler tube leak.
Sept.27/85	-	No.2 boiler shut down with a second boiler tube leak.
Sept.30/85	-	Repairs completed and Unit No.2 in service to commission the turbine.
Oct. 1/85	-	C.E. Canada were told N.B. Power is ready to resume testing in Unit No. 2 with OX-CE fuel.
Oct. 7/85	-	OX-CE fuel (partly settled) was tested in the Unit No. 2 boiler but only poor fires were obtained.
Oct.9/10/85	-	A representative from the OX-CE fuel company was on site in Chatham to check fuel.
Oct. 11/85	-	The OXCE representative reported chemicals would be sent to the Chatham Plant to treat the OX-CE fuel which was in the storage bunker.
Oct.15-18/85	-	OX-CE personnel on site to re-work their fuel and burn it in Unit No.2.
	-	There was a large amount of fall out and high opacity during the burning of the 70 tons of rehabilitated OX-CE fuel.
	-	The last 30 tons were burned between 17:10 and 24:00 hours.
Oct. 21/85	-	OX-CE said they will not be sending new fuel to Chatham and would be re-working the fuel on site.
Oct. 28/85	-	OX-CE personnel returned to the Chatham Plant to rehabilitate some of the fuel remaining on site ready for the burn test.
	-	All day was spent mixing one car of fuel to get the coal back into suspension, before it could be unloaded.
Oct. 29/85	-	One rail car of OX-CE fuel was unloaded into the in-plant storage bunker and new chemicals were added.
Oct. 30/85	-	Two CWF guns in service burning OX-CE fuel with support ignition.
	-	The opacity readings were high.

- For 45 minutes, one CWF gun was run successfully with steam atomization before the gun plugged with fuel that had been dried in the gun barrel and atomizer tip.

Oct. 31/85 - After operating for some time, three CWF guns were in service with stable fires burning OX-CE fuel with no ignitors, and one heavy fuel oil gun at half load.

- The opacity reading at the meter was close to 50%*, after the burners had settled down.

- It was, therefore, concluded there was no way four CWF guns at full, without support ignition, could be in service in this boiler and maintain an acceptable opacity level.

* NOTE: - With Unit No.1 boiler fans in operation, this opacity was reduced to 37% at the discharge to boiler stack.

Nov. 1/85 - Unit No.2 in service with two heavy oil guns at half load, and two CWF guns with OX-CE fuel at full load with light oil ignitors, to burn out the remaining OX-CE fuel in the in-plant storage bunker.

- Good stable fires were obtained (with support ignition).

- The one empty and two full rail cars of settled OX-CE fuel were returned to OX-CE Fuel Company in Jacksonville, Florida.

- This completed the test program for the "OX-CE" fuel and new "CE" burners.

- Overall test schedule is in Appendix "C" of this report.

5.2 Boiler Modifications - Unit No.1 (Front Fired)

- Chatham Unit No.1 boiler is a front fired "Foster Wheeler" boiler with four burners, rated at 12.5 MWe electrical output.

- The unit was originally designed to burn pulverized coal, but was converted to heavy fuel oil firing in the early 1960's

- In preparation for burning coal-water fuel, the four heavy fuel oil burner registers were replaced. This requires major boiler burner front modifications to accomodate the new and larger burner registers.

- All burner front pipes and control valve stations were modified to accomodate the extra fuel system for coal water fuel.

- An additional two ignitor guns per burner were also added.

- All of the refractory on the inside surface of the front water wall was replaced.

5.3 Boiler Modifications Unit No.2 (Corner Fired)

- Unit No.2 boiler is a "Combustion Engineering" tangentially fired boiler with four burners, rated at 22 MWe electrical output.

- It was originally designed to fire pulverized coal and converted to heavy fuel oil firing in the early 1960's.

5.3.1 The following modifications were required to prepare the boiler for coal-water fuel firing and were completed in the Spring of 1984:

- The removal of the eight old coal burners and coal supply piping.

- The removal of the burner tilts.

- The closing of combustion air supply to the coal burners.

- The installation of new burner throats.

- The installation of a combustion air booster fan and system with ducts to each corner burner.

- The removal of the old ignitors.

- Installation of four new and larger ignitors.

- A new combustion air system for each new ignitor.

- Separate guns were required for both the CWF and fuel oil firing.

- Therefore the original Bunker "C" fuel oil guns, associated piping, and burner front control stations could be used. But a new burner front control stations for the CWF guns had to be installed at each corner with the required piping and controls for CWF, atomizing air, atomizing steam, and purge and flush water.

- 200 psi atomizing steam system installed.

- 150 psi atomizing air system installed.

- Relocate refractory bricks blocking off part of the old combustion air supply.

- Windbox dampers were checked. The sealing improved where necessary.

- Pressure taps and thermocouples to measure air temperature and pressure in the windbox and air heater ducting.

- Install instantaneous fuel and atomizing medium flow measurement at "B" corner.

In the Fall of 1984 the following additional modifications were carried out:

- Refractory panels were added to corners "B" and "D".

- New burner throats installed.

- The secondary air burner inlet ports were relocated.

- Sealing improved within CWF guns.

5.3.2. During the week of July 15, 1985, Combustion Engineering Superheater Limited carried out the following additional modifications to the burners in the Chatham Unit No. 2 boiler.

- The burner throats were replaced with reshaped and larger quarls (buckets) to both reduce the velocity of the primary air and to improve the frame attachment to the burner tips, also to improve recirculation with in the flame to give more complete combustion of the coal water fuel.

- The exit ports of the secondary combustion air compartments were reduced in size to increase the velocity of the secondary air to improve the aerodynamics of the the fire ball in the furnace area of the boiler.

- The primary air swirlers were replaced in each burner with new ones of a more efficient design to reduce the pressure drop through them.

- The light oil ignitions were lowered to just below the burner throat to avoid interference between the ignition flames and the new and larger burner (quarl) throats.

- For details of the four different burner arrangements which have been tested during the two demonstrations programs in the unit No. 2 boiler, see appendix "D" of this report.

- For a cross section of the atomizer nozzles used, see Appendix "D" of this report.

5.4 Fuel

- The Oxidental Petroleum Corporation and Combustion Engineering Company formed the OX-CE Fuel Company for the purpose of developing and marketing a coal-water fuel.

- The OX-CE Fuel Company donated free of charge the 500 tons of their coal-water fuel required of this demonstration. The Project paid for the transportation cost and rail car rental.

- The changes in fuel characteristics from the first inspection of the railcars when they arrived in Chatham/Newcastle area up to the time the fuel was actually burned are covered in the following sections.

5.4.1 Fuel Specification

The OX-CE C.W.F. was supplied in accordance to the following specification:

Analysis	Measurement	Maximum/Minimum
HHV	BTU/Lb.	9,800 minimum
Ash	%, Dry	6.0 maximum
Sulphur	$Lb/10^6$ BTU	0.6 maximum ($1.2\ Lb/10^6$ BTU SO_2)
Viscosity	cp @ 78°F and 100 sec.-1	2,500 maximum
Volatile Content	%, Dry	30 minimum
Moisture Content	%	35 maximum

5.4.2 History of the Fuel

- The fuel used for this demonstration was manufactured in the Fall of 1984. It remained in storage until June 1985 when it was shipped to N.B. Power's Chatham Plant. The fuel manufacturer ("OX-CE") reported the fuel had been prepared in the fall of 1984 because they thought the demonstration was going to start in early 1985.

July 15, 1985

- Six rail tanks cars of OX-CE coal water fuel arrived at the CN rail siding in Newcastle, N.B. (a few kilometers from the Chatham Station).

- The fuel in each car was inspected and samples were taken for testing at the Chatham Generating Station Laboratory (see Appendix A for test results).

August 8, 1985

- A representative of the OX-CE Fuel Company visited the Chatham Plant to check reports the fuel in the rail cars was starting to settle, with water on top of the fuel and a thick sludge at the bottom.

August 22, 1985

- A second representative from the OX-CE Fuel Company visited the site. He personnally inspected the fuel in the rail cars and recommended that arrangements be made as quickly as possible to burn the fuel from the three rail cars in which the settling of the fuel was greatest.

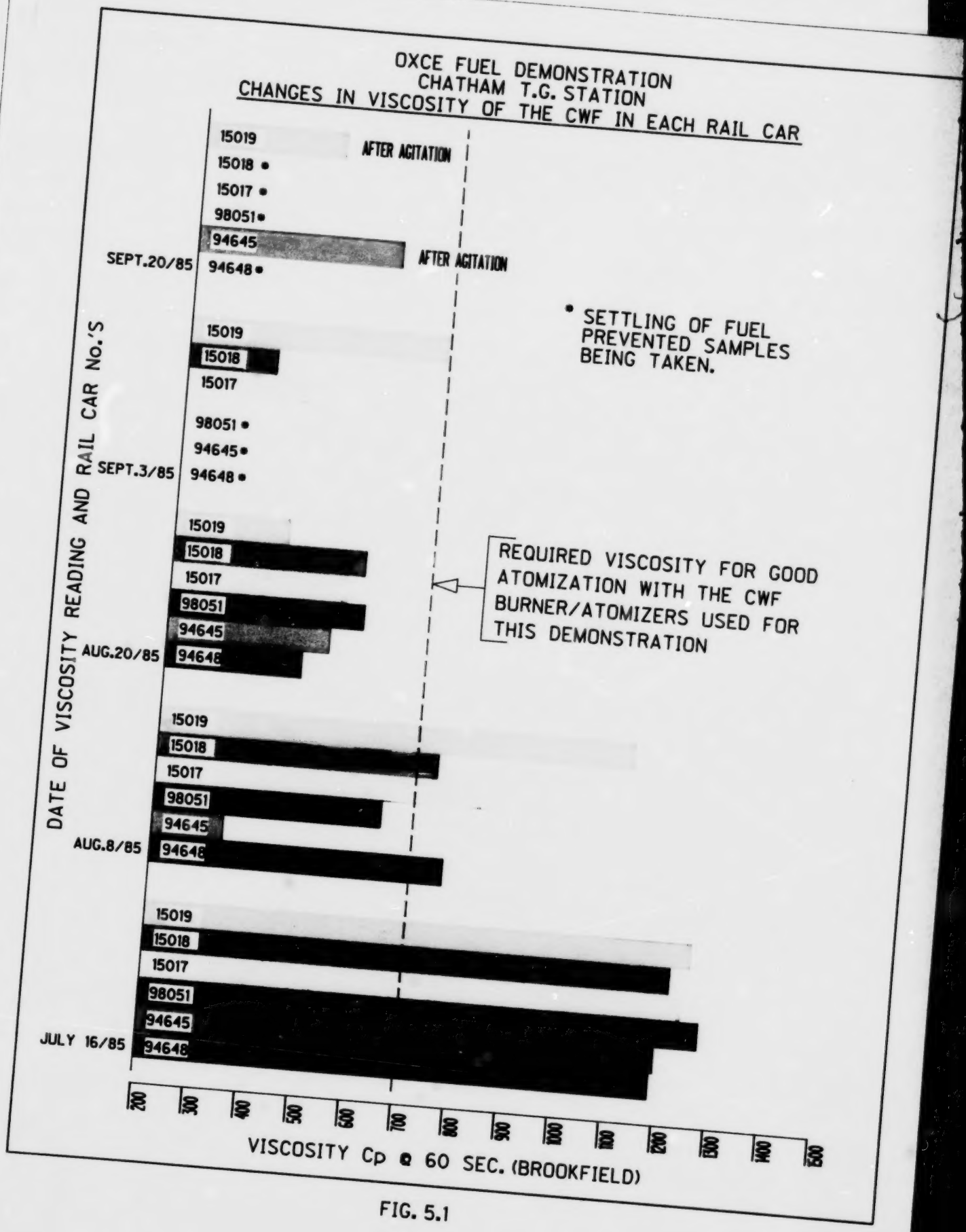


FIG. 5.1

CHATHAM
1
OXCEFUEL

5.4.3 Burning OX-CE Fuel

August 29, 1985

- When the fuel from tank car N°98051 was unloaded there was approximately two (2) feet of settled fuel in the bottom of the rail car, which would not flow until water had been added to it and it had been agitated with compressed air lances.

- Approximately 40 manhours were required to remove the settled fuel from the bottom of the rail tank car.

On September 6, 1985

- The OX-CE fuel which had been unloaded from tank car No. 98051 was burned in Unit No. 1 boiler.

- Poor combustion was experienced because of the high moisture content of the fuel.

September 12 and 16, 1985

- The OX-CE fuel from rail cars No. 09465 and No. 09468 was unloaded and some of the fuel was burned in Unit No. 1 boiler on September 16, 17, 19 and 20.

- Weather conditions and high stack opacity limited burning times to 4-6 hours per day, for these four days.

October 1, 1985

- C.E. Canada were informed that Unit No. 2 boiler was available and the OX-CE fuel demonstration could be switched to the Boiler No. 2.

- For an analysis of the fuel burnt, see Appendix "E" of this report.

October 7, 1985

- Unit No. 2 was on line burning OX-CE fuel. The problems with fuel consistency resulted in poor fires. The fuel had changed taking on a "gel" like consistency which resulted in plugging of the guns.

- A representative of the OX-CE Fuel Company took samples of this fuel to his company's laboratory for analysis.

- The retreatment of this fuel is covered in Appendix A & E of this report.

October 17, 1985

- Technicians from the OXCE Fuel Company came to the Chatham Plant to rehabilitate their fuel.

- Fuel additives (powered dispersant) were added to the fuel in the storage bunker at the point where the recirculation line discharges the coal water fuel back into the hopper. The OX-CE technician felt this would provide sufficient dispersion for the chemicals.

- After the addition of the fuel additives, the coal water fuel was recirculated through the in-plant fuel system for twenty-four hours to ensure uniform distribution of the additives in the fuel.

- The mixing improved the atomization of the fuel resulting in stable fires in Unit No. 2 boiler.

October 18, 1985

- The remaining 30 tons of OX-CE fuel in the storage bunker was burned in Unit No. 2 boiler between 17:10 and 24:00 hours.

- By this time three rail cars of fuel had been burned.

- N.B. Power and the OX-CE Fuel Company concluded that the remaining three rail cars (Nos. 15019, 15018 & 15017) would be unloaded one at a time into the plant storage bunker.

- The reason for this the fuel would have to be rehabilitated by adding dispersent prior to burning.

- The earlier rehabilitation had shown it would improve the combustion quality of the fuel.

- A performance test to establish efficiency of the new burners was planned at full load with no support ignition.

- The experience gained from the test on the fuel from the fourth rail car would be used to determine whether or not the fuel from the two remaining rail cars would be rehabilitated and burned.

October 28 to November 1, 1985

- Two technicians from the OX-CE Fuel Company arrived at the Chatham plant to rehabilitate the fuel.

- Fuel in tank car N°15019 was air lanced for twelve (12) hours to get the coal back into suspension before it was transferred from the tank car in to the plant storage bunker.

- The fuel was then treated with 0.05% dispersent (by weight of fuel) using the same procedure as before.

- Unit No. 2 boiler was on line and adjustments were completed by October 30.

- The performance test was carried out on October 31.

- Fuel samples were collected from burner front, and ash samples taken from the bottom ash pit and fly ash hoppers.

- The full load test had to be limited to 3 CWF guns at full load with no light oil ignitors and one heavy oil gun at part load, because of the high opacity from the boiler stack under these condition. (See fig. 7.1).

- After completion of the test, the remaining fuel (approx. 10 tons) was burned on November 1, 1985 to empty the plant storage bunker.

- Atomization of the fuel was poor so all parties involved agreed that the two remaining tank cars full of OX-CE fuel would be returned to OXCE Fuel's Jacksonville Plant in Florida.

5.4.4 Summary - Fuel

- The OX-CE fuel was received in mid July.

- The test could not be undertaken at that time (refer to Pages 4 and 5) and the fuel remained in the rail tankers for 7-8 weeks.

- 3 weeks after delivery, the fuel began to settle.

- When testing was started, the fuel had settled to a stage which affected the burning and handling properties of the fuel.

- The fuel was rehabilitated with chemicals (fuel additives) to restore its properties.

- The mixing facilities at the Chatham Plant are limited, therefore, the original properties of the fuel were not fully obtained.

- The fuel did, however, burn with stable fires but the high opacity of the gas made it necessary to provide oil support in order to meet the required opacity level.

- Fuel analysis charts and records are found in Appendix E of this report.

6.0 BOILER OPERATION, UNIT NO.1 (Front Fired)

- OX-CE fuel was burned in Unit No.1 boiler on three separate occasions.

- Bright stable flames were achieved without the support of light oil ignitors but it was necessary to have at least one main oil gun burning bunker oil to minimize the opacity of the flue gas exiting the stack.

- Unit No.2 fans were operated to provide additional dilution of the flue gas which has the effect of reducing the opacity of the flue gas leaving the stack.

- The following observations were made during these tests:

Viscosity of CWF at burner front	500-600 cps at 24°
Density of CWF	1.19
Moisture level in CWF	31.77-33.26%
Minimum CWF consumption/burner	50 Lbs/min.
Maximum CWF consumption/burner	70 Lbs/min.
CWF header pressure	70 psig to 95 psig
Atomizing air pressure	110 psig - 120 psig
Heavy Oil pressure	78 psig - 80 psig
Light Oil pressure	60 psig
Heavy Oil consumption/burner	36.40 Lbs/min.
Windbox pressure	2"-2.2"WG
Combustion air with 4 guns, (2 - OX-CE + 2 - H. Oil)	103,000 lbs/hr.-105,000 lbs/hr.
Dilution air from No.2 unit fans	100,000 lbs/hr.
Load with 4 guns (2 - OX-CE + 2 - H. Oil)	6.5 MWe
Load with 2 guns (1 - OX-CE + 1 - H. Oil)	5.0 MWe
Opacity with 2 guns (1 - OX-CE + 1 - H. Oil)	30% (meter reading)
Opacity with 4 guns (2 - OX-CE + 1 - H. Oil)	45% (meter reading)
Opacity with 3 guns (2 - OX-CE + 1 - H. Oil)	50% (meter reading)
Unburnt combustibles in fly ash	59.75%
Unburnt combustibles in bottom ash	75.0%

- All tests were carried out using Foster Wheeler's "Forney guns".

- Steam atomizing was not used.

- The operation of Unit No.1 boiler on this fuel was limited by opacity.

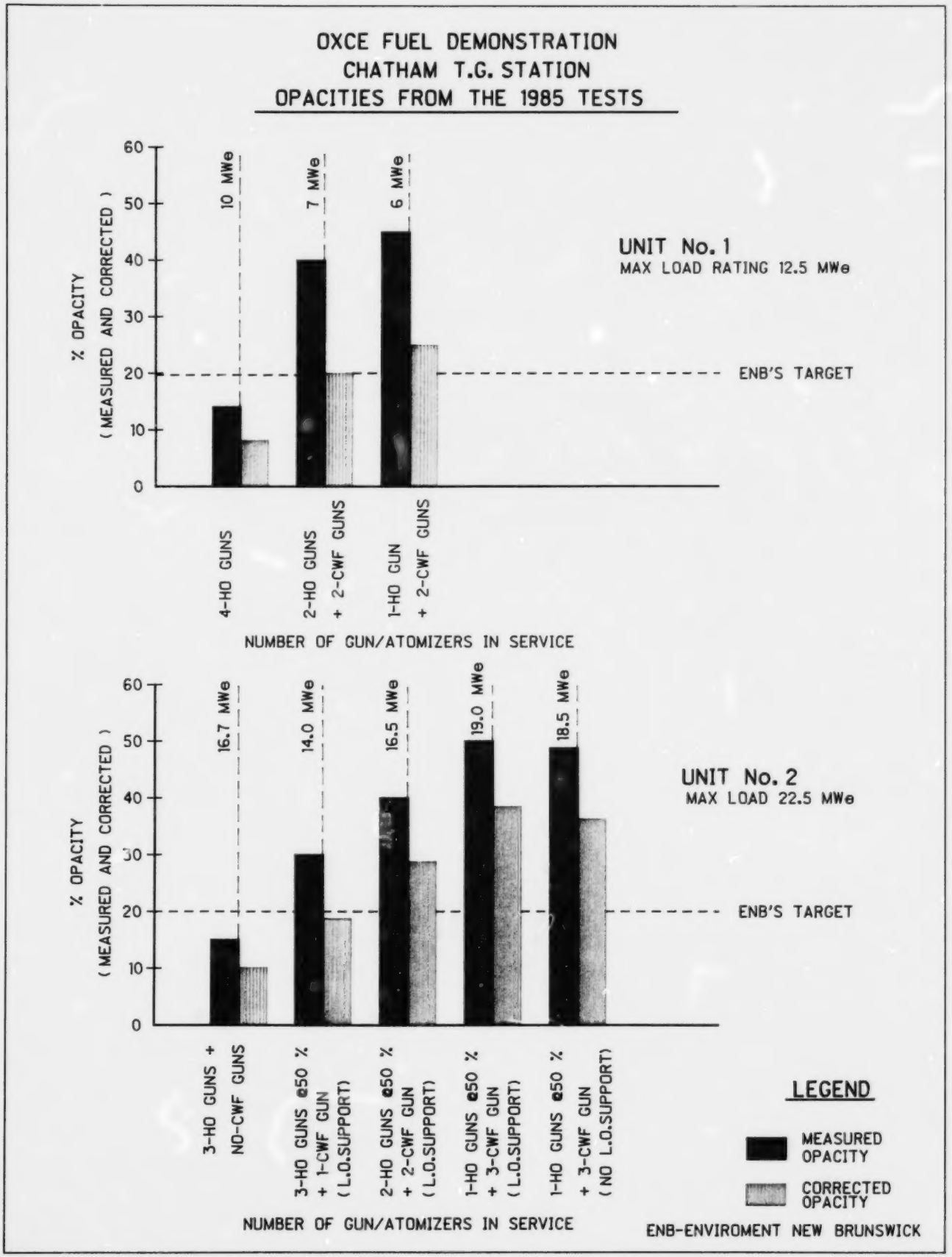


FIG.7.1

CHATHAM
1
OPACITY

- The unburnt combustibles in the bottom and fly ash samples would chiefly be unburnt carbon in that the sulfur content of the coal water fuel is 0.55%.

- Detailed information is in Appendix A of this report.

7.0 BOILER OPERATION, UNIT NO.2 (Corner Fired)

- OX-CE fuel was burned in Unit No.2 boiler on six (6) separate occasions. Bright stable flames were achieved without the use of ignitors, but it was necessary to have at least one oil gun in service at all times to support combustion and reduce opacity.

- Higher atomizing air and fuel (OXCE) pressures were required with the CE guns in unit No. 2 than were required with the Fourney guns in Unit No.1.

- Steam atomizing was tried and good atomizing and stable fires were achieved but after less than one hour of operation the burner atomizer tips plugged and the guns had to be removed from service.

- During all of these tests, the Unit No.1 boiler fans were operated to provide dilution air to the flue gas from Unit No.2 thereby reducing the opacity of the flue gas from the boiler stack.

- The following observations were made during these tests:

Viscosity of CWF at burner front	380 cps @ 22°C (Oct.30/ Nov.1).
Density of CWF	1.19
Moisture level in CWF	32.56%
Minimum CWF consumption/burner	90 Lbs/min.
Maximum CWF consumption/burner	116 Lbs/min.
CWF header pressure	175 psig
Atomizing air pressure	180 psig
Atomizing steam pressure	150 psig to 190 psig
Heavy oil pressure	60 psig
Light oil pressure	250 psig
Heavy oil consumption per gun	63.1 Lbs/min.
Windbox pressure	5" to 6" WG
Dilution air from Unit No.1 fans	80,000 Lbs/Hr. (Ambient)
Load with 4 guns (3 - OX-CE + 1 - H.Oil)	11.5 MWe
Load with 4 guns (2 - OX-CE + 2 - H. Oil)	13.0 MWe
Load with 4 oil guns	22.0 MWe
Opacity with 4 guns (2 - OX-CE + 2 - H. Oil)	40%
Opacity with 3 guns (2 - OX-CE + 1 H. Oil)	45%
	45%
Opacity with 4 guns (3 - OX-CE + 1 H. Oil)	55%

Unburnt combustibles in fly ash	59.75%
Unburnt combustibles in bottom ash	75.0%

- It was observed when the ignitors were removed from service on the CWF guns (3 OX-CE guns and 1 heavy oil gun in service), the OXCE flames moved to 12 inches to 18 inches off the atomizer tips while the heavy oil flame remained attached to the oil atomizer tip.

- All test were carried out using CE fourth generation burners.

- The operation of Unit No.2 boiler, during this demonstration was limited by opacity.

- The unburnt combustibles in the bottom and fly ash samples would chiefly be unburnt carbon because the sulphur content of the coal water fuel was 0.55%.

- Detailed reports are included in Appendix A of this report.

8.0 ENVIRONMENTAL

- During the testing of the OX-CE fuel, the only means of removing particulate from the flue gas emitted from Units 1 and 2 boilers was by the mechanical multi-cyclone dust collectors located in the discharge ducts.

- This type of dust collection system is reasonably efficient on large size particulate (greater than 25 microns) but efficiency is dramatically reduced when flue gas particulate is under 20 microns, as was experienced on this demonstration.

- The experience gained while firing in coal-water fuels has shown that the flue gas particulate is very fine resulting in a detectable brown colour to the plume measured as percentage opacity.

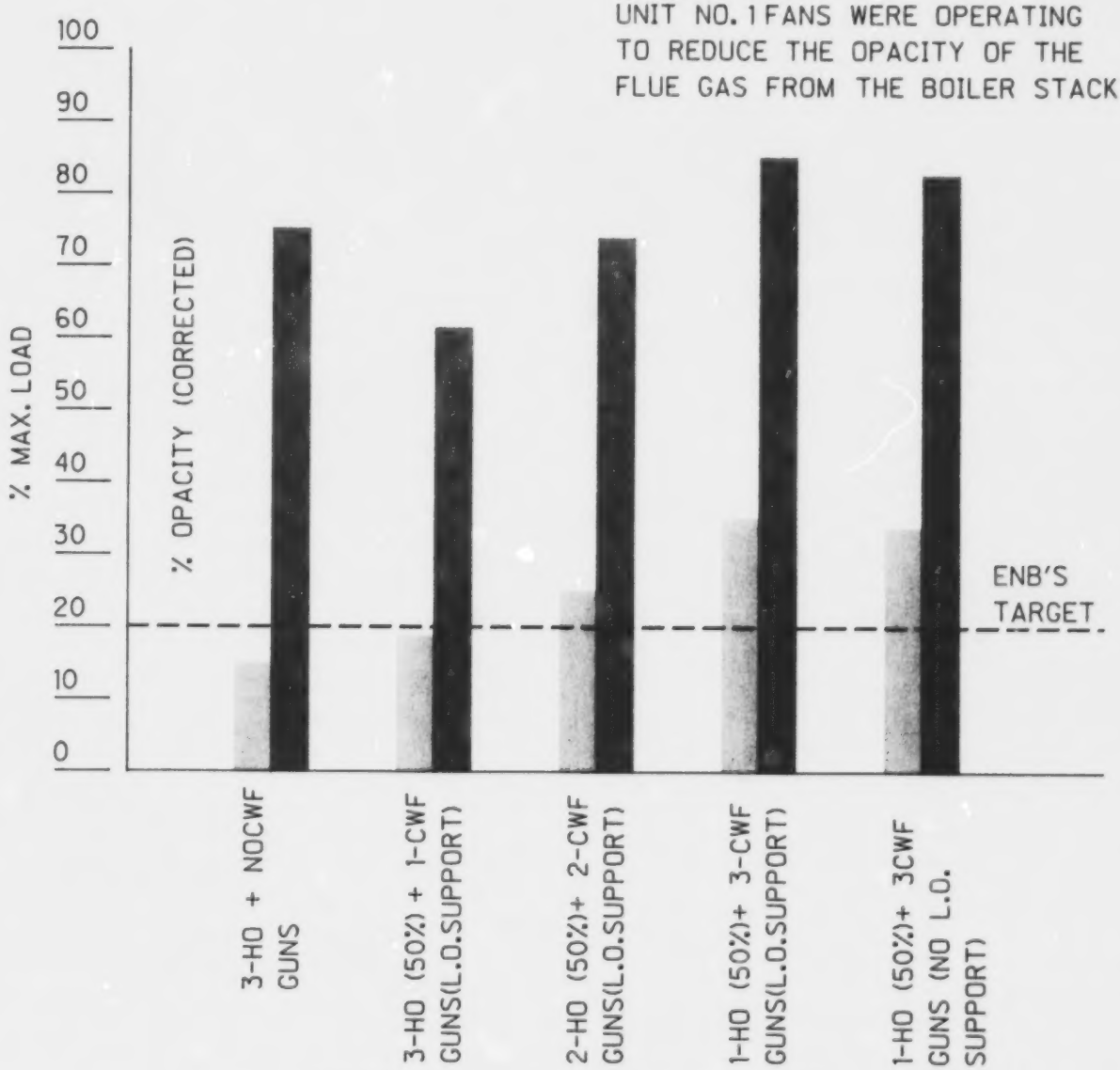
- In order to comply with the environmental regulations meters were installed in the breeching of both Units 1 and 2 boilers to measure the opacity of the flue gas prior to it entering the common stack.

- Canadian Applied Technology Ltd., supplied a Model 400/ 400A measurement system, which provided a guage reading of opacity and a strip chart of the measured opacity in Unit No.1 breeching.

- A portable "Lear Seigler" RM41P meter provides a guage reading of the opacity in the unit No.2 breeching, and a chart record of this opacity.

OXCE FUEL DEMONSTRATION
CHATHAM T.G. STATION
GRAPH OF OPACITY VS LOAD ON UNIT
FOR UNIT No. 2

NOTE:
UNIT NO. 1 FANS WERE OPERATING TO REDUCE THE OPACITY OF THE FLUE GAS FROM THE BOILER STACK



ENB-ENVIROMENT NEW BRUNSWICK

FIG. 8.1
PAGE 22

CHATHAM
1
OXCEDEMO

- It was concluded that the existing mechanical multi-cyclone dust collectors on both of these boilers are inadequate for capturing the very fine particulate when firing coal-water fuels.

- During this demonstration it was necessary to burn support oil when firing the coal-water fuel to reduce the opacity of the flue gas.

- In addition the flue gas had to be diluted by running the boiler fans of the unit not in service. (There were two boilers at the Chatham Plant feeding into a common boiler stack). This was done to further reduce the opacity of the flue gas from the boiler stack.

- This operating procedure, although effective in reducing the opacity, did not provide sufficient reduction in opacity to allow full load operation on either unit while burning OX-CE fuel.

9.0 Conclusions

- Unit No. 1 (the front fired unit) was operated on rehabilitated OX-CE fuel and bright stable fires were achieved with light oil ignitors in operation and heavy oil burners in adjacent ports.

- Unit No. 2 (the corner fired unit) operated on rehabilitated OX-CE fuel giving bright, stable fires, with no light oil ignitor in operation and only one heavy oil burner in service at half load.

- A fly ash sample taken from the mechanical dust collectors in unit N°2 had about 60% combustibles in it. The ash in the original fuel was approximately 6.0% (dry).

- The CWF firing rate on the units was limited by flue gas opacity exiting from the stack.

- In general, the OX-CE fuel burned very similar to the CBDC Carbogel and was quite easily rehabilitated with additives and simple mixing.

- An efficient fly ash particulate collector is required when burning any type of coal-water fuel.

DSS File No. 15SQ.23440-4-9299
Contract Serial No. OSQ85-00013

TITLE: Combustion and Performance Testing of OX-CE Coal Water Fuel at the Chatham N.B. Generating Station

VOLUME 2

APPENDIX TO FINAL REPORT

PROJECT MANAGER

D.M. RANKIN

Work on the Project was conducted under the auspices of the Canadian Center for Mineral and Energy Technology, Energy, Mines and Resources Canada.

DSS File No. 15SQ.23440-4-9299
DSS Contract File No. OSQ85-00013
CANMET Project No.
CANMET SCIENTIFIC AUTHORITY: Dr.H.Whaley

DATE: May 1986

OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

APPENDIX TO FINAL REPORT

TABLE OF CONTENTS

APPENDIX	TITLE
A	Test Reports
B	Cost Summaries
C	Schedule
D	Diagrams
E	Fuel Data Charts
F	Test Procedures
G	Test Equipment Used
H	Purchase Orders

"OX-CE" FUEL DEMONSTRATION

AT N.B. POWER'S CHATHAM T.G. STATION

APPENDIX "A"

TEST REPORTS

INDEX

DATE	SUBJECT	PREPARED BY
July 23, 1985	Test of the Unit No. 2 boiler after the C.E. Canada modification and the new atomizer tips.	M.R. Thanisch N.B. Power
July 26, 1985	Review of work for the week of July 20 to 26, 1985.	M.R. Thanisch N.B. Power
Aug. 30, 1985	Site report on an "OXCE" fuel burn.	K. Keoughan N.B. Power
Sept. 6, 1985	Report on an "OXCE" fuel burn in Unit No. 1.	M.R. Thanisch N.B. Power
Sept. 6, 1985	Site report on an "OXCE" fuel burn.	K. Keoughan N.B. Power
Sept. 16, 1985	Site report on an "OXCE" fuel burn.	K. Keoughan N.B. Power
Sept. 19, 1985	Site report on an "OXCE" fuel burn.	K. Keoughan N.B. Power
Oct. 7, 1985	Site report on an "OXCE" fuel burn.	K. Keoughan N.B. Power
Nov. 4, 1985	Report on the "OXCE" fuel test in Unit No. 2 from October 30, 1985 to November 1, 1985.	M.R. Thanisch N.B. Power
Nov. 4, 1985	History of CWF burns during the and fall of 1985.	M.R. Thanisch N.B. Power

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MANUFACTURER'S REPORTS

Nov. 18, 1985	Report from CE Canada for "OXCE" burn test week of Oct. 28, 1985.	M. Ward C.E. Canada
Feb. 18, 1986	"OXCE" fuel analysis Chatham Demonstration.	G.W. Dubin OXCE Fuel Co.

DATE	SUBJECT	PREPARED BY
March 14, 1986	OXCE Coal-Water Fuel Burn Test Chatham Unit No. 2, OXCE, Fuel Analysis.	S.A. Morrison C.E. Canada
March 24, 1986	Modification on Chatham Unit No. 2 prior to "OXCE" Fuel Firing.	D. Cook C.E. Canada
April 24, 1986	Movie film of "OXCE" Coal-Water Fuel Burn Test, Chatham Unit No. 2.	R. Feindel C.E. Canada

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OPACITY READINGS

Oct. 1985	Measured and corrected opacity reading for Unit No. 1 and Unit No. 2.	N.B. Power
Oct. 31, 1985	Opacity chart with boiler No. 2 in service.	N.B. Power

FILE CWF 3-6-C
Coal Water Burner Development
OXCE TEST - REPORT
Date 23/July 85

REPORT ON SITE VISIT
TO THE CHATHAM T.G. STATION

DATE — 23 July 85

REASON FOR VISIT — To witness the start-up of Unit No.2 after C.E. Canada had made a number of changes to the Unit No.2 Burners.

REPORT OF VISIT — I arrived at the Chatham Plant at 1 PM. C.E.'s new atomizer tips were due to arrived on the noon flight, from Montreal but the flight was over an hour late.

The tips finally arrived at the plant at 2 PM, and one tip was installed on a gun by 3 PM. The CWM gun was inserted in the Burner at "B corner" and the CWF System pressure increased so the gun could be brought in to service. When this was done the pinch valve's rubber sleeve ruptured.

The System pumps were shutdown, and the pinch valve isolated. The CWF System was brought back into service using the Masoneilan valve. Next the "B corner" ignitor would not stay lit. The gun was checked and it was found the atomizing air pressure was low, the air regulator was removed and cleaned. It was re-installed and still the ignitor would not work, so the regulator from "Corner D" was installed with no sucess. Next the regulator was removed and replaced with a section of pipe, by then it was 6:30 PM.

6:40 PM - CWF gun in service with an ignitor.
Atomizing Air (at gun) - 140 PSIG.
CWF (at gun) - 145 PSIG.
CWF Flow - 70 lb/min.
Opacity - 39%.

6:45 PM - Windbox pressure increased.
Opacity - 29%.

6:53 PM - Windbox Pressure increased to 5" W.G.(primary air).
Opacity - 22%

6:55 PM - A Air - 140 PSIG.
CWF - 145 PSIG.
Flow - 71.4 lb/min.
Opacity - 22%.

7:07 PM - Opacity up to 32%.
- Some fall into the ash pit.

7:08 PM - A Air - 140 PSIG.
CWF - 144 PSIG.
Flow - 74.0 lb/min.
Opacity - 28%.

7:10 PM - Atomizing Air Pressure increased.
A. Air - 160 PSIG.
CWF - 146 PSIG.
Flow - 69 lb/min.
Opacity - 20%.

7:15 PM - Ignitor combustion air cut back.
Opacity - 20%.

7:16 PM - Ignitor combustion air cut back more.

7:17 Pm - Opacity swinging - 19 to 21%.

7:18 PM - Opacity - 19%.

7:25 PM - CWF flow increased to full load.
- The ignitor is still in-service.
A Air - 160 PSIG.
CWF - 160 PSIG.
Flow - 108 lb/min.
Opacity - 26%.

7:28 PM - Opacity - 29%.
NOTE: The stack looked very good from outside.

7:30 PM - Atomizing Air Pressure increased.
A. Air - 180 PSIG.
CWF - 160 PSIG.
Flow - 106 lb/min.
Opacity - 31%.
It was noticed the secondary air damper was closed - It was opened.

7:33 PM - A. Air - 175 PSIG.
CWF - 160 PSIG.
Flow - 107 lb/min.
Opacity - 32%.
Primary air pressure 5" WG. CWF pressure at pump discharge in basement 195 PSI.

8:00 PM - The stack viewed from the Chatham Bridge with no visable smoke 200 feet from top of stack.

8:30 PM - The test program for the day was complete. The ignitor was not removed from "Corner B" to test burning the CWF without support.

- While in Chatham, I met with Len Leblanc, who was on site to plan how the CWF (OXCE Fuel) could be burnt directly from the rail cars by by-passing the storage tank, incase the CBDC fuel now in the bunker cannot be burnt in Unit No.2.

- I also attended the meet with the C.T.S. group who are now in Chatham to check out all the unit No.2 auxiliary equipment, while the boiler and turbine are in service.

Prepared by

M. R. Thanisch

FILE: CWF
OXCE Test

DATE: 26 July 1985

SITE REPORT

CHATHAM PLANT

UNIT NO. 2

OXCE TEST PROGRAM

SUBJECT:

Review of the past week's work on Unit No. 2 (July 20 to 27, 1985).

DETAILS:

Saturday, 20 July - By mid day relocation of the CWF (Coal Water Fuel) burner front supply pumps was completed, the system flushed and checked out, and the CWF back on recirculation.

Sunday, 21 July - CWF in bunker being recirculated.

Monday, 22 July - Combustion Engineering (C.E./KDL) checking out and calibrating their equipment.

- The staging was removed from the unit No. 2 boiler after completing the CE/KDC burner modifications.

Tuesday, 23 July - Unit No. 2 was ready to go on line in the morning to test the new CE/KDL burner/atomizers modifications on carbogel fuel.

- The new CE/KDL atomizers did not arrive at the Chatham Plant until 2 PM.

- Unit No. 2 was on-line at 2:45 PM.

- One atomizer was installed in a CWF gun by 3 PM.

8:30 PM - The test program for the day was complete. The ignitor was not removed from "Corner B" to test burning the CWF without support.

- While in Chatham, I met with Len Leblanc, who was on site to plan how the CWF (OXCE Fuel) could be burnt directly from the rail cars by by-passing the storage tank, incase the CBDC fuel now in the bunker cannot be burnt in Unit No.2.

- I also attended the meet with the C.T.S. group who are now in Chatham to check out all the unit No.2 auxiliary equipment, while the boiler and turbine are in service.

Prepared by

M. R. Thanisch

SITE REPORT ON AN OXCE FUEL BURN

30 AUG 85

K. KEANGNAM — OXCE FUEL BURN No. 1 — AUGUST 30 1985

OXCE FUEL IN BUNKER OUTAGE 19' 10½" 62.4 TONS

8:23 No. 1 UNIT ON LINE
BOIN ISOLATING VALVES BUNKER "C" SUPPLY TO No. 4
BURNER LEAKING BY OIL GUN IN No. 4 BURNER

9:20 No. 2 FANS ON AIR FLOW 100,000 LB/HR
C.W. FUEL BUNKER SAMPLE VISCOSITY 5000 SSU @ 25°C
DENSITY 1.19
MOISTURE 33.16%

9:30 No. 3 BURNER LIT OFF ON OXCE FUEL
HAD TO MOVE GUN & COOLING TUBE ¼" INTO BOILER TO
GET STABLE SWIRL - BURNER SLAGGED OVER GUN OUT
BURNING SLAG (UNBURNT FUEL) OFF WALL AFT

10:30 No. 3 GUN BACK IN OXCE FUEL SWIRL IS STABLE BUT
CENTRE VERY DARK - OPACITY 50-60%. INCREASED OIL TO
BURNER GUNS OPACITY DROPPED SOME - STACK LOOKS FAIR.
ADJUSTED WINDBOX PRESS - AIR FLOW & FUEL PRESS. TO
IMPROVE OPACITY. PRIMARY DAMPER OPEN 2 NOTCHES

12:30 No. 2 BURNER IN ON OXCE FUEL GUN & COOLING TUBE
MOVED INTO BLR FIRE GOOD & BRIGHT BUT UNABLE
TO GET STABLE SWIRL OPACITY UP 50%. REDUCED
C.W.F. PRESS TO 30 PSIG AGAIN ATOM AIR 115-120 PSIG
WINDBOX 2 TO 2.2" wg. AIR FLOW 105,000 LB/HR.

13:00 C.W. FUEL BUNKER OUTAGE 20' 11" 52.5 TONS
No. 3 FIRE GOOD SWIRL & BRIGHT PRIMARY DAMPER
OPEN 3 NOTCHES
OPACITY 45% ON CHART STACK DON'T LOOK BAD

NOTE: PIECE OF D.F. IZER VANE No. 1 BURNER BROKEN OFF No. 1
OIL FIRE A BIT DIRTY - REDUCING OIL PRESS TO No. 1 GUN

13:30 REMOVING No. 1 BUNKER C. GUN - DIDN'T HELP OPACITY
ADJUSTING AIR FLOWS - DAMPERS & PRESSURES SAME AS
ATOM AIR STAYING THE SAME
OPACITY AROUND 40% ON CHART STACK LOOKS GRAY NOT DARK.

13:50 C.W. FUEL BUNKER OUTAGE 21' 4¾" 49.2 TONS
STACK LIGHT LOOKS NOT BAD OPACITY READING 50-55%

ADJ VALVE TO MAINTAIN 30% OPACITY 25 To.

19:00 C.W. FUEL BUNKER OUTAGE 15'2¼" - 19400 - 116.4 TONS

20:00 " " " " 15'4½" - 19000 - 114.0 TONS

BURNT 2.4 TONS OVER FUEL IN No 4 GUN LAST HOUR

NOTE. AFTER GUN WENT DOWN OPACITY STARTED GRADUALLY INCREASING

NO CHANGES MADE TO BUR OR GUNS. UP TO 33-35% STACK

STILL LOOKS GOOD - No 4 BURNER GOOD.

21:00 C.W. FUEL BUNKER OUTAGE 15'5½" = 18750 = 112.5 TONS

BURNT 1.5 TONS No. 4 GUN LAST HOUR. CAN'T KEEP OPACITY

BELOW 30% - DIFFICULT TO SEE STACK - SHUTTING UNIT DOWN.

File: CWF 3 Chatham Coal/Water
Burner Development - OXCE Test
Burn in Unit No.1

SITE VISIT - CHATHAM GENERATING STATION

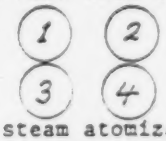
Friday, September 6, 1985

SUBJECT: TO WITNESS THE BURNING OF OXCE FUEL IN UNIT No.1

DETAILS

1:00 p.m. CWF Bunker measured

2:00 p.m. Two burners with oil at low pressure
Two burners with OXCE CWF at 70 psi



BURNER LOCATION VIEWED FROM BURNER FRONT.

Burner #1 Oil with steam atomization
Burner #2 Oil with steam atomization
Burner #3 OXCE - good swirel and stable
Burner #4 OXCE - no noticeable swirel, just a bushy fire but stable

No.4 swirel vanes were adjusted back to the required angle of 35°. This did not improve the flame in No.4. The fire stayed bushy and too big to see the burner throat.

Opacity reading 45% (there is said to be a 10 to 15% error) corrected reading 30 to 35%.

2:15 p.m. Video camera used to record the OXCE CWF burn.

2:40 p.m. The operator checked No.4 burner and reported the swirler on the gun was still in place.

2:48 p.m. No.1 Oil 80 psi
A, Steam 100 psi

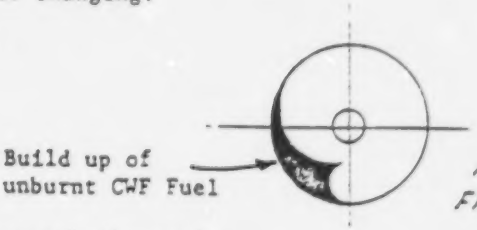
No.2 Oil 78 psi
A, Steam 100 psi

No.3 OXCE 75 psi
A, Air 106 psi

No.4 OXCE 70-75 psi
A, Air 100 psi

2:55 p.m. For no reason, the swirel on No.4 burner improved - one could see it changing.

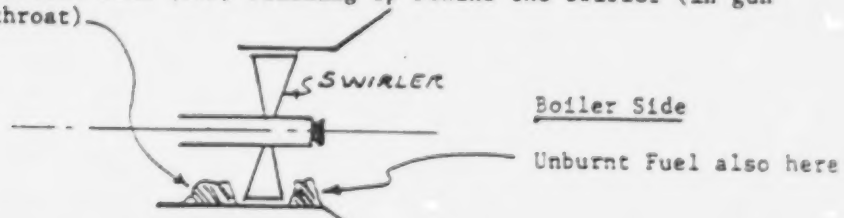
2:57 p.m. No.4



3:07 p.m. No.4 went bushy again.

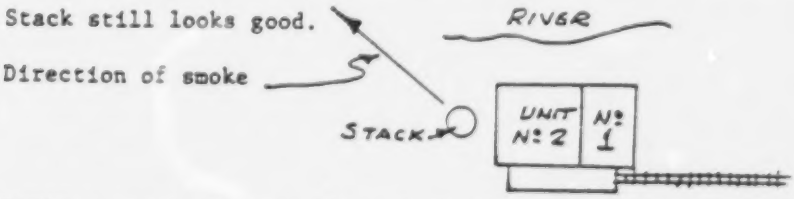
NOTE: Air compressor (from C.E. Canada)
Atlas Copco
PNS 1200
100% oil free air

3:16 p.m. Unburnt fuel (CWF) building up behind the swirler (in gun throat)



3:18 p.m. No.4 gun moved into boiler to try and stop build up in throat.

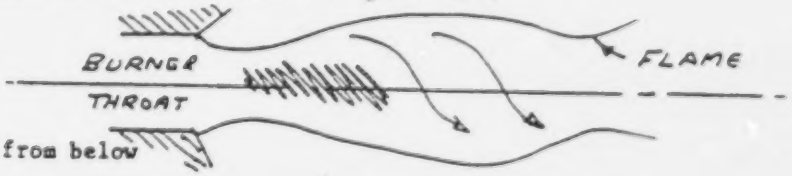
3:20 p.m. Fuel (oil and CWF) and atomizing pressures are still the same.



3:22 p.m. Ignitor put in No.4 so that the build up can be blown off with the combustion air by opening and closing the dampers.

3:25 p.m. Most of build up removed and ignitor removed.

3:32 p.m. The centre of the No.3 flame has gone dark.



3:35 p.m. Viewed from below

No.3 looks very stable but still has a dark centre.
No.4 has better shape and a good swirel but not as good as Nº 3
No noticeable fall out into bottom of throad furnace - apart from lumps of unburnt fuel from No.4 burner throat.

3:40 p.m. Opacity reading 45% - 15 = 30%

3:41 p.m. Load on Unit No.1 is 6.5 MW

3:53 p.m. No.1 oil gun removed - opacity went up 5%.

4:00 p.m. Mike McGrath started to record flames and smoke stack with his video equipment.

4:06 p.m. Load dropped to 5 MW's.

4:07 p.m. Load picked up a bit to 5.5 MW's.

4:27 p.m. No.3 CWF (OXCE) still looks very good.
No.4 is still ragged with a very dark centre.

4:28 p.m. No.4 very poor. CWF pressure jumped to 85 psi.

4:30 p.m. No.1 oil put back in service.

4:33 p.m. CWF pressure reduced to 70 psi.
No.4 improved a bit but No.3 went darker in colour.

4:35 p.m. Slage unburnt fuel rack on No.4.

4:39 p.m. Opacity back down to 45-10=35%.
No.2 fans <u>not</u> in service.

<u>NOTE</u>:

- The CWF (OXCE Fuel) in the in-plant bunker was burnt out at 8:30 p.m. Friday evening and the system was then flushed out with water. The No.3 gun improved as the fuel level in the bunker dropped. As the fuel level dropped, the moisture content would be going up - but mixing of the fuel should have been improved.

- The No.4 burner remained stable but with a bushy flame - chaning the gun position within the burner throad - and adjusting the swirel vanes and dampers did not improve the No.4 burner.

- The No.4 burner atomizer tip will be inspected once it has been removed from the boiler.

Prepared by: M. R. Thanisch

SITE REPORT ON AN OXCE FUEL BURN

6. SEPT. 85

OXCE FUEL BURN — SEPTEMBER 6, 1985

1110 – No 1 UNIT ON LINE. 2 ON FUEL GUNS IN SERVICE
No 3 GUN 4000 SQUARE – STABLE
No 4 No SMALL DARK FIRE
CAMERA SET UP TO FILM BURN
BURNT 3.9 TNS BETWEEN 13:00 & 14:00 HRS
3R.2 TNS LEFT

NOTE – MOISTURE 2% HIGHER AT TOP OF BUNKER COMPARED TO SAMPLE AT BOTTOM OF BUNKER

2035 – N. 1 UNIT OFF LINE. RUNBACK 3V 7.5 K.P.H.
BUNKER EMPTY.

No 4 DINNER SHARED MOST OF DAY. ALSO USED PILOTS TO BURN SIAB LEFT. ALSO USED BARRELS TO BURN SLAG OUT OF THROAT. WHEN THROATS WERE CLEAR, STABLE SQUARE WAS ATTAINED & FIRE LOOKED BETTER

OXCE FUEL BURN

SEPTEMBER 16, 1985

UNLOADING SECOND CAR OF "OXCE" FUEL

BOTH OPACITY METERS CLEANED CALIBRATED & USED NO 1 BLR BREECHING.

13:40 NO 1 UNIT ON LINE

14:15 OPACITY RUNNING 35% NO. 1 RECORDER NO 2. FANS OFF FOR W. CAMMERON TO X-RAY NO. 2 BLR.

ADJUSTING GUN POSITION TO TRY & STABILIZE FIRE NO LUCK.

HAVE TO KEEP PILOT IN SERVICE WINDBOX PR = 1.9" WG.

C.W. FUEL 120 PSIG ATOM AIR 100 PSIG

UNABLE TO DO ANYTHING WHILE UNLOADING CAR FUEL PRESSURE JUMPING ALL OVER THE PLACE ON NO 3 C.W.F BURNER

14:45 NO. 3. C.W. FUEL GUN OUT OF SERVICE. UNBURNT FUEL BUILD UP ON SECONDARY THROAT 12 O'CLOCK TO 7 O'CLOCK.

16:00 OPACITY 43% NO 1 METER 52% PORTABLE P.T.S. STACK LOOKS REASONABLY GOOD TO NAKED EYE SMOKE WHITE SM - GREY

NO 1 & 2 ON BUNKER "C"

NO 4 ON C.W. FUEL - NO SWIRL RUSTY FLAME QUITE BRIGHT

16:05 NO 4 GUN OUT OF SERVICE

NO 1 METER OPACITY 15% PORTABLE P.T.S. 19%

DIFFICULT TO ANCHOR FLAME TO GUN IN NO. 1 BURNER

ADJUSTING GUN ASITION, DAMPERS, WINDBOX PRESSURE

NOT MUCH LUCK.

16:15 MOVED NO 1 BUNKER GUN TO NO 3 BURNER

16:30 NO 4 GUN IN ON C.W. FUEL OPACITY 30% NO 1 METER NO 2 FANS ON AIR FLOW 115,000 LB/HR. NO SWIRL BUSTY FLAME FIRE LOOKS TERRIBLE. SOOT C.W.F 110 LB A. AIR WINDBOX 2" WG.

TRIED EVERYTHING OPACITY 133% POOR FIRE NO SWIRL

16:50 NO 4 C.W. FUEL GUN OUT OF SERVICE 2'2" WG WINDBOX TIP LOOKED OKAY - DIST PLUG BLOWN OUT NEW TIP INSTALLED

17:05 NO. 4 BACK IN GOOD FLAME SWIRL. 17:10 PILOT OUT STABLE SWIRL CENTRE A BIT DARK WINDBOX 2.2" WG.

C.W.F 95 PSIG A. AIR 118 PSIG AIR FLOW 103,000 LB/HR

NO 1 OPACITY READING 32%. OPACITY SETTLED AT 38%. STACK LOOKS GOOD - REDUCED C.W.F PRESS TO 95 PSIG.

NOTE: C.W. FUEL HEADER PRESSURE KEPT INCREASING. OPACITY 32% REDUCING HEADER PRESS TO 90 PSIG. PRESS STILL INCREASING OPENING RECIRC TO HOLD 90 LB / C.W. FUEL PRESS. STACK LOOKS GOOD OPACITY NO 1 - 30 = 32% PORTABLE P.T.S. 37.5%

NO 4 GUN GOOD BRIGHT EDGE STABLE SWIRL CENTRE GOOD & BRIGHT

C.W. FUEL HEADER PRESS 80 PSIG CONTINUOUSLY ADJUSTING RECIRC VALVE TO MAINTAIN 80 PSIG OPACITY 25%.

19:00 C.W. FUEL BUNKER OUTAGE 15'2¼" = 19400 = 116.4 TONS

20:00 ✓ ✓ ✓ ✓ 15'4½" = 19000 = 114.0 TONS

OXCE FUEL TEST

SEPTEMBER 19, 1985

8:35 No. 1 UNIT ON LINE
8:45 No 4 BIT OFF OXCE FUEL
9:10 OUT No 4 GUN OPACITY PROBLEMS HIGH
9:20 No 3 GUN IN "OXCE" FUEL
9:50 No 3 GUN OUT OPACITY
10:00 No 3 GUN IN "OXCE" FUEL - STABLE SWIRL CENTRE A BIT DARK OPACITY RUNNING 35-40% STACK LOOK REASONABLY GOOD
11:00 No 4 GUN IN "OXCE" FUEL OPACITY UP TO 55%. SETTING UP GUN
11:05 OIL MOTOR 34698.2 PILOT OUT
No 1 OPACITY METER 50% PORTABLE ATS. 78%
STACK STILL DONT LOOK TOO BAD
11:30 No 3 & 4 GUNS ON OXCE FUEL No 1 & 2 BUNKER "C"
STACK LOOKS GOOD FAIRLY WINDY SUNNY CLEAR +24C
No 1 OPACITY METER HOLDING 45%
LOAD 5.5 MW VACUUM 3.1" Hg WITH QUICK START ON
12:30 SETTING V.C.R CAMERA ON BOILER HOUSE ROOF TO MONITOR & RECORD STACK PLUME
NOTE: No CHANGE IN OPACITY WITH PILOTS IN WITH OXCE GUNS
13:30 RUNNING 45% No 1 METER 73-75% ATS METER
AIR FLOW 103,000 LB/HR WINDBOX 2-6 2.2" wg
OXCE FUEL 70 PSIG ATOM AIR 122 PSIG
12:00 - 13:00 HRS BURNT 4.2 TONS TWO (2) ON FUEL GUNS
13:00 - 14:00 HRS " 3.6 TONS
OUTAGE 14'3" 21700 BBL 130.2 TONS
NOTE: FUEL SEEMS TO BE SETTING OUT A BIT OF WATER ON TOP OF FUEL
9:30 "OXCE" FUEL SAMPLES:

	BUNKER TOP	BNKR BOTTOM	BURNER FRONT
VISCOSITY	410 @ 23°C	670 @ 23°C	510 @ 24°C
DENSITY	1.19	1.20	1.20
MOISTURE	34.01%	31.22	31.17%

17:25 BUNKER OUTAGE 15'6" 18670 BBL 112.1 TONS BURNT 18 TONS
CENTRE OF FIRES DARK - HAZEY IN ASH PIT SMOKE NOT BAD
18:02 WIND DROPPED OFF OPACITY 50% STACK STILL DONT LOOK TOO BAD FUEL PRESS AT HEADER 100 PSIG
19:00 STACK STILL DONT LOOK TOO BAD BUT GETTING HARDER TO SEE
21:00 No 1 UNIT OFF No WIND UNABLE TO SEE PLUME OF STACK

THE NEW BRUNSWICK ELECTRIC
POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE
DU NOUVEAU BRUNSWICK

KEN BROWN
HEAD OFFICE

K. KEOUGHAN OPERATIONS 86/02/05

OXCE BURN OCT 7/85 No. 2 BLR

8:15 No 2 UNIT ON LINE 9:45 "A" GUN IN ON C.W.F. OPACITY ROADING 100% TO STACK LOOKS OKAY - CHECKING METER. 11:00 TO 11:03 TRIED SECOND GUN REMODED STACK VERY BAD. 12:50 SECOND GUN BACK IN OPACITY 25% - No.1 BLR FANS WERE ON. GUNS PLUGGING ON FUEL SIDE COOLING H2O ON TO SUCTION LINE HEAT EXCHANGER TO REDUCE FUEL TEMP. AT GUNS - NO LUCK STILL PLUGGING 14:40 "A" GUN PLUGGED 16:00 "A" GUN BACK IN 16:40 BOTH C.W. FUEL GUNS PLUGGED 18:00 UNIT OFF LINE BUNKER 11:50 SURFACE 17' 10½"

12:50 ✓ 18' ½"

13:50 ✓ 18' 3½"

File: CWF-3
OX-CE Test - Fuel
and Burner Test

1985-11-04

NOTES FROM SITE VISIT
of M.R.Thanisch

LOCATION: Chatham Plant Unit No.2

DATE: October 30 to November 1, 1985

SUBJECT: OX-CE Fuel Test and C.E. Burner Test in Unit No.2

DETAILS: - People on site for test:

Mike Ward	- C.E.Canada - Ottawa
Rich LeFlesh	- KDL - Windsor, Connecticut
Martin Prieto	- OX-CE Fuel Co.- Windsor, Connecticut
Ken Peterson	- OX-CE Fuel Co.- Windsor, Connecticut

I arrived at the Chatham Plant at 9:45 a.m. but the Unit No.2 boiler was not in service because there was a problem with the controller on the bypass valve for the high pressure heaters.

Unit No.2 was put in service at lunchtime at a reduced load with the high pressure heaters out of service, while Lowel Lewis tried to repair it. (Joe Innes, the Plant Electrician, was on vacation for a couple of days, as it was the start of hunting season).

2:30 p.m. One CWF gun with OX-CE fuel was put in service and the stack looked very bad with the gun at half load.

Details of OX-CE fuel: (As Burnt)	Viscosity	- 380 cps
	Moisture	- 32.56%
	Temperature	- 22°C
	Density	- 1.19
Analysis of OX-CE fuel: (From OX-CE Spec)	Coal	- 61%
	Ash	- 6%
	Additives	- 1%
	Water	- 32%

2:45 p.m. Unit No.1 boiler fans put in service at *80,000 lb/hr. (This is a reading from the steam flow scale).
* There is no air flow scale on the recorder.

2:50 p.m. The stack looks better - viewed from the base of the stack, outside the Plant.

2:55 p.m. CWF flow increased to close to full load and opacity went very high (70% on meter) and stack looked very bad (Keith said you could walk on the smoke from the stack).

3:00 p.m. Load on the one CWF gun was dropped to 1/3 load, opacity still very high.

3:20 p.m. CWF flow increased. CWF Flow - 116 lb/min.
Pressure - 175 psig
Atomizing Air - 180 psig
Ignitors were in service, and opacity - 66% (at meter)

3:30 p.m. An extra heavy oil gun put in service and the opacity dropped to 35% at meter.

NOTE:

- One operator reported when the *combustion air flow to the CWF gun was increased, most of the air flow to the oil guns was **lost. Once the air flow was increased to the oil guns, the opacity dropped from 75 to 35% at meter.
  * wind box air pressure
  ** is this possible?

- Full load fuel flow for carbogel - CWF = $\frac{25{,}000 \text{ lb/hr.}}{60 \text{ min/hr.}}$ = 416 lb/min.
  - 104 lb/min. to one CWF gun.

  The OX-CE fuel has a lower heating value than carbogel, so the flow had to be increased.

4:00 p.m. Opacity still good and no fire flyes in the upper part of boiler.

4:05 p.m. 'B' corner ignitor removed - opacity stayed at 34% (at meter) CWF flow - 112 lb/min.
Pressure - 170 psig
Atomizing Air -180 psig

4:10 p.m. Opacity went up to 55%. Wind box pressure lowered to try and pull the CWF flame back into the throat.

4:20 p.m. Opacity cycling between 45% and 75% at meter. Rich LeFlesh could not get flame to stay attached to the burner throat.

4:23 p.m. The operator tried to reduce the CWF flow to the one burner but the pumps are at their minimum speed.

NOTE: The opacity monitor in the breeching elbow is being shaken quite a bit.

4:30 p.m. Opacity went very high and the ignitor was put back in service - opacity - 50% (at meter).

4:32 p.m. Some CWF fuel is being bypassed back to the bunker.

CWF Flow	- 90 lb/min.
Pressure	- 150 psig
Atomizing Air	- 183 psig
Opacity Cycling	- 30 to 50%

Load on the unit was 10 to 12 MW all afternoon.

4:49 p.m. The atomizing air pressure was reduced.

CWF Flow	- 102 lb/min.
Pressure	- 140 psig
Atomizing Air	- 150 psig

NOTE: Without adjusting fuel system, the flow increased 15%. Opacity 55% at meter (with ignitor in service).

4:52 p.m. Atomizing air pressure increased.

CWF Flow	- 92 lb/min.
Pressure	- 150 psig
Atomizing Air	- 180 psig
Temperature out of Bunker	- 60°F

5:00 p.m. Service/instrument air line broke between three air receivers which supply air to Unit No.1.

5:25 p.m. Unit No. 1 boiler fans were shut down due to a loss of control (instrument) air. The Unit No. 1 boiler fans were being used to increase the air flow up the stack and therefore reduce the opacity of the gas leaving the stack.

5:37 p.m. "B" Corner

Opacity	- 30-35%
CWF Flow	- 93 lb/min
Pressure	- 155 psig
Atomizing Air	- 180 psig
Opacity	- 25% (at meter)

Ignitors in-service

All three oil guns running at 60 psig heavy fuel oil and atomizing steam 80-90 psig.

Getting ready to test steam atomization in "B" corner with the OXCE fuel.

5:50 p.m. Switch to steam atomization while on-line with the gun in-service.

CWF Flow	- 118 lb/min
Pressure	- 125 psig
Atomizing Steam	- 190 psig
Opacity	- 30% (at meter)

5:54 p.m. CWF Flow - 112 lb/min
Pressure - 190 psig
Atomizing Steam -190 psig
Opacity - 30%

6:02 p.m. CWF Flow - 115 psig
Pressure - 124 lb/min
Atomizing Steam -150 psig
Opacity - 35%

By reducing atomizing steam pressure the flame moved back into the burned throat.

Windox Air Temp. - 448°F

6:10 p.m. "B" corner ignitor remove opacity went up to 35% (swinging between 32 and 35%).

6:13 p.m. Flame about 15" to 18" off burner throat.

6:20 p.m. Plan for next step. Try a second CWF gun in "D" corner - A run two guns at a lower CWF pressure and flow.

6:30 p.m. Still having problems to get "D" corner ignitor in-service. "B" corner ignitor was put in-service with no problem.

6:33 p.m. "B" corner CWF gun plugged and had to be taken out of service (the burner was using atomizing steam). There was a plug of about 2 inches of dried fuel in the gun and atomizer tip.

The burner with steam atomization was in-service for 43 minutes.

7:00 p.m. Testing for the day was stopped and the unit shut down and kept hot over night.

Thursday October 31/85

8:00 a.m. This morning when the operators tried to put Unit No. 2 on-line they had a problem obtaining a vacuum in the condenser, so they shut the unit down.

The by-pass valve controller could not be repaired over-night.

Problems in the Morning:

- Auxiliary steam safety valve
- Condenser Vacuum
- H.P. heater control valve
- OXCE fuel was not heated over night
- Burner ignitor hard to get lit

Weather:

Clear and cool, with a light to moderate wind out of the north.

Temperature 4°C.

Atomizer Tips:

Today the tips with a narrow spay angle were used.

1:00 p.m. Ignitor finally lit-off on "C" corner and CWF (OXCE) gun put in-service. (This corner was used because there was a problem with the heavy fuel oil flow to the gun).

1:20 p.m. CWF gun brought up to full load.

1:36 p.m. "C" corner
CWF Pressure - 160 psig
A Air - 165 psig
Opacity (at meter) swinging between 35-45%

1:39 p.m. Opacity 31-35%

1:45 p.m. Opacity 26%

2:00 p.m. Feedwater heater by-pass valve was tested and the control motor burnt out.

2:15 p.m. I checked with Joe Innes on the motor and minimum time it can be wound in is 3 days.

2:30 p.m. I checked with Jack Flangan and he said they can not run the H.P. heater control valve on partial by-pass.

2:45 p.m. I asked Rich LeFlesh (KDL) to put a second C.W.F. gun in-service in "A" corner.

2:47 p.m. Opacity reading still 26%. It has been steady for an hour.

During this time KDL/OXCE shot a film of the fire through the TV port in the boiler wall, with one CWF gun in service.

2:50 p.m. "A" corner oil removed, after a big but short duration swing in the opacity, reading was 27% (at meter).

Steam temperature is 896°F, normal full load is 840°F.

3:00 p.m. CWF gun installed and operators increasing (CWF) fuel flow.

3:03 p.m. CWF flow to "A" corner at full load, opacity up to 40% but coming down a bit.

3:05 p.m. Two CWF gun at full load.

Opacity - 40% (at meter)
Load on Unit: 13 MW, but H.P. heaters not in-service

3:15 p.m. Unburnt fuel falling into the ashpit and forming 2" to 3" layer which is continuing to burn.

KDL/OXCE preparing to shoot a second film of the fire through the "TV" port.

3:20 p.m. Opacity is swinging between 38 and 40% (This could be due to the location of the meter in the 90° elbow).

NOTE

The ignitors have been in the CWF guns - whenever they have been in-service today.

3:28 p.m. TV camera removed so a second film can be taken of the fire (with two CWF guns in service with ignitors).

3:31 p.m. "A" Corner, CWF- 165 psig
Atomizing Air - 180 psig
"C" Corner, CWF- 165 psig
Atomizing Air - 185 psig

3:39 p.m. KDL/OXCE finished taking their second film.

There are no noticeable fire-flyies in the super heater area of the boiler.

3:42 p.m. The opacity has settled down to 36-37% at meter (about 25% at top of stack as the Unit No. 1 boiler fans are in-service).

3:50 p.m. Operator preparing to put a third gun in-service in "B" corner.

When the oil gun was removed the opacity went up to 45%.

4:05 p.m. CWF flow being increased.

4:06 p.m. Third CWF gun in-service. Opacity 55% (high of 62%) at meter.

4:10 p.m. The stack (output) is a light brown (beige) colour - a high percentage of the opacity could be from the moisture in the fuel (30%) and from the high percentage of ash in the coal used for the OXCE fuel.

Smoke visable some distance from the plant.

4:13 p.m. Opacity swinging between 60-65%.

4:16 p.m. "A" corner CWF - 160 psig
Atomizing Air - 178 psig
"B" Corner CWF - 155 psig - Flow 90 lb/min
Atomizing Air - 182 psig
"C" Corner CWF - 162 psig
Atomizing Air - 180 psig
"D" Corner Oil Heavy - 40 psig
Atomizing Steam- 52 psig
Load on Unit - 11.5 MW (the H.P. heaters are still being bypassed)

4.26 p.m. Wind box air flow increased and opacity came down to 50 to 55% (at meter).

4:45 p.m. Opacity - 48% (at meter)

4:46 p.m. "B" corner ignitor removed.

Opacity stayed at 48%.

Rich said flame in "B" became more stable and attached to throat.

4.48 p.m. "C" corner ignitor removed and flame stayed 8" off throat.

The flames were being pushed to one side by the ignitors, so when the ignitors were removed the flame shape improved and became more attached to the burner throat.

Opacity at 48%.

Note: There is about half load on the oil gun.

4:58 p.m. Opacity - 50%
One heavy oil gun.
One CWF gun full load with an ignitor.
Two CWF guns full load without ignitors.

5:00 p.m. "A" Corner CWF - 162 psig
Atomizing Air - 178 psig
"B" Corner CWF - 154 psig
CWF Flow - 99 lb/min.
Atomizing Air - 188 psig
"C" Corner CWF - 162 psig
Atomizing Air - 182 psig
"D" Corner Heavy Oil - 45 psig
Atomizing Steam- 62 psig

Note:

KDL/OXCE wished to take a third film but there were no full bottles of nitrogen left and no regulators available to use another gas.

As there was a small amount of gas in the old bottle they shot their film as long as possible with 3 CWF guns in-service at full load, with no ignitors, and one oil gun at half load.

5:09 p.m. Opacity - 52%

5:12 p.m. TV camera removed and third the ignitor from "A" corner.

Opacity - 50%

5:17 p.m. All three CWF flames above 12" off throats.

Oil flame attached to throat.

5:19 p.m. Fall out into ash pit and burning - about 6"+ deep.

5:25 p.m. Shutting unit down because of a lower level in the heavy oil day tank.

Friday November 1/85

Unit No. 2 in-service to burn the remaining reworked OXCE fuel in the in-plant storage bunker.

Two heavy oil guns and two CWF guns with ignitors were used. The ignitors could not be removed because, as the OXCE fuel in the bunker was burnt and the level dropped the fuel became thicker, which could have plugged the atomizer/guns.

All the OXCE fuel in the bunker was burnt by 2:30 p.m. and good fires had been obtained during the burning.

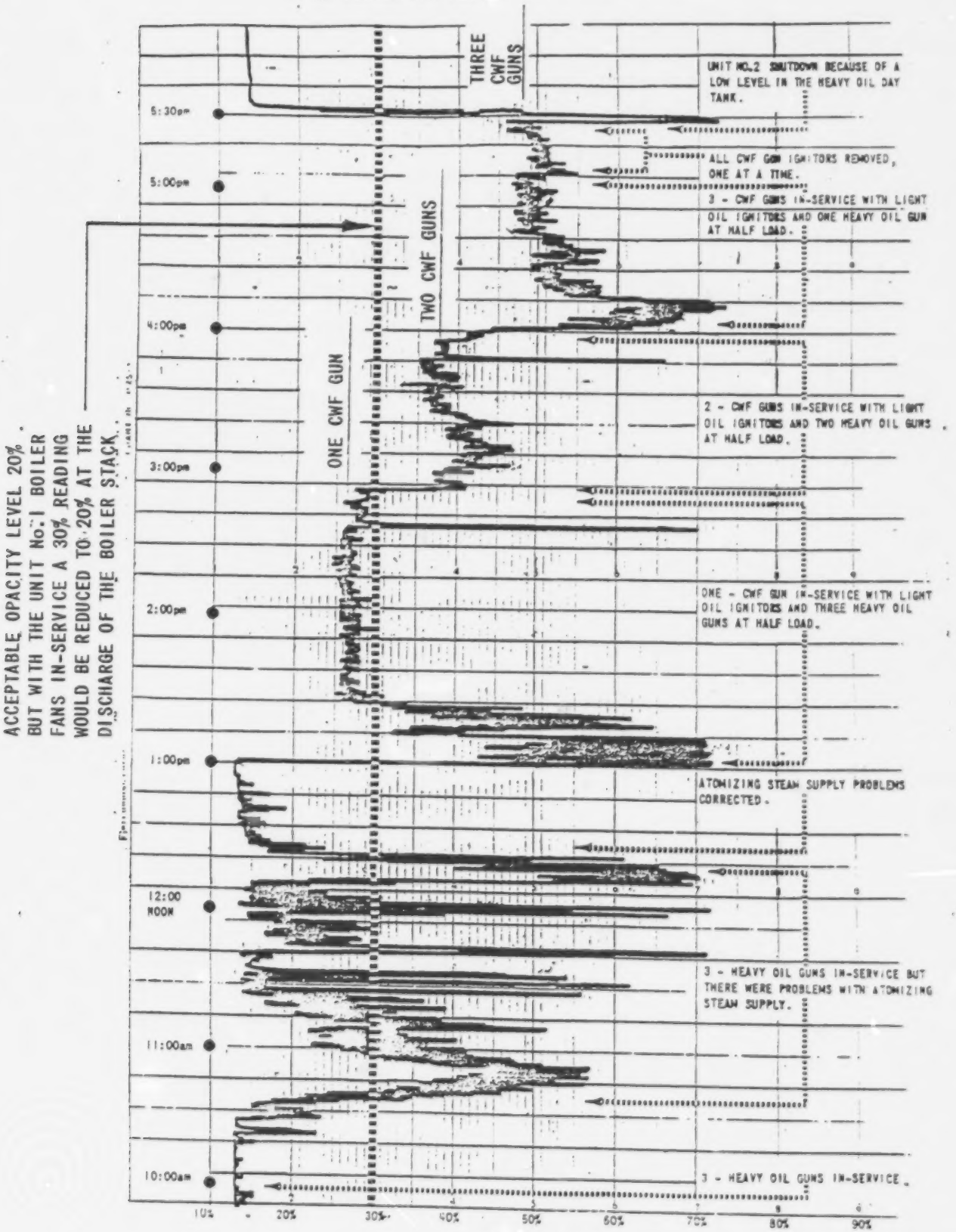
37.2 tons of OX-CE fuel were burnt with two CWF guns in about 6 hours.

This completed this phase of the "OXCE" Fuel, and "C.E." Burner Test Program.

Prepared by:

M.R. THANISCH

OPACITY READING TAKEN ON 31st OCTOBER 1985 WHILE "OXCE" FUEL AND "CE"-BURNERS WERE BEING TESTED IN UNIT No. 2 AT THE CHATHAM T.G. STATION


THREE CWF GUNS
TWO CWF GUNS
ONE CWF GUN
UNIT NO.2 SHUTDOWN BECAUSE OF A LOW LEVEL IN THE HEAVY OIL DAY TANK.
ALL CWF GUN IGNITORS REMOVED, ONE AT A TIME.
3 - CWF GUNS IN-SERVICE WITH LIGHT OIL IGNITORS AND ONE HEAVY OIL GUN AT HALF LOAD.
2 - CWF GUNS IN-SERVICE WITH LIGHT OIL IGNITORS AND TWO HEAVY OIL GUNS AT HALF LOAD.
ONE - CWF GUN IN-SERVICE WITH LIGHT OIL IGNITORS AND THREE HEAVY OIL GUNS AT HALF LOAD.
ATOMIZING STEAM SUPPLY PROBLEMS CORRECTED.
3 - HEAVY OIL GUNS IN-SERVICE BUT THERE WERE PROBLEMS WITH ATOMIZING STEAM SUPPLY.
3 - HEAVY OIL GUNS IN-SERVICE.
5:30pm
5:00pm
4:00pm
3:00pm
2:00pm
1:00pm
12:00 NOON
11:00am
10:00am
10%
20%
30%
40%
50%
60%
70%
80%
90%
OPACITY READING

ACCEPTABLE OPACITY LEVEL 20%. BUT WITH THE UNIT No. 1 BOILER FANS IN-SERVICE A 30% READING WOULD BE REDUCED TO 20% AT THE DISCHARGE OF THE BOILER STACK.

TAKEN WITH THE METER LOCATED IN THE 90° ELBOW AT DISCHARGE OF THE UNIT No. 2 BOILER I.D.-FAN

FILE. CWF 3.5.1
DATE: 4 NOV 85

HISTORY OF C.W.F. FUEL AND BURNER TESTING
Summer/Fall 1985

NRC Burner Test - CWF 4

April - Preparation for NRC Test Program.

April 19 - Carbogel (CWF) Fuel left Sydney, N.S.

April 25 - 3 rail cars of CWF from Sydney arrived at the Chatham Plant.

May 13 - NRC on site in Chatham to start their burner test program.

May 14 - Water spray test on new burner/atomizers.

May 15 - Further burner testing.
- NRC left site.

May 31 - Opacity meter installed and commissioned.

June 4 - Reviewed, Unit No. 1 Burner No. 1 throat modifications requested by NRC.

June 5 - Carbogel - CWF starting to settle in bunker.

June 7 - Burner No. 1 throat modified so that the Primary and Secondary would mix before reaching the atomizer tip.

June 8 - Water spray test on the modified No. 1 burner.

June 14 - The shape of Burner No. 1 throat changed by the addition of refactory.

June 18 - NRC returned to Chatham to test the reshaped No. 1 burner throat.

- The large NRC gun would only give a load of 25×10^6 BTU - less than half the required load.

OXCE Fuel Test - CWF 3

Unit No. 2 out of service while C.E. Canada/KDL rebuilt their burners and atomizer.

NRC Burner Test - CWF 4	OXCE Fuel Test - CWF 3
June 22 - NRC left Chatham.	
	June 25 - KDL on site to check the Unit No. 2 ignitors.
	- Six cars of OXCE fuel (CWF) shipped from Jacksonville, Florida.
July 3 - EMR/NRC returned to Chatham to test a new deflector on the gun in the No. 1 modified burner throat, and test a new swirler in Burner No. 4.	
July 5 - Second shipment of 3 rail cars of carbogel (CWF) received from Sydney.	
- EMR/NRC left Chatham.	
July 8 - Project review meeting at NRC office in Ottawa.	
- NRC will build a larger CWF gun/atomizer with a capacity of 55 x 10^6 BTU.	
	July 15 - CE/KDL on site to install their modified burner/ atomizers.
July 16 - Carbogel (CWF) in the bunker is settling.	July 16 - OXCE Fuel (CWF) arrived in Chatham/ Newcastle.
July 19 - Stabilizer recieved and added to CWF in bunker.	
	July 20 - CWF burner front supply pumps relocated.
July 22 - Fuel sterilizer received and added to CWF in bunker.	

NRC Burner Test - CWF 4

July 30 - More problems with the settling of the carbogel in the bunker.

Aug. 12 - Unit No.1 in service to burn up the CWF fuel (carbogel) in the bunker.

OXCE Fuel Test - CWF 3

July 23 - Unit No.2 boiler ready but the new C.E. atomizer tips did not arrive in Chatham until late on July 23. It was late in the evening before a CWF gun was in service burning carbogel (CWF).

July 24 - Unit No.2 unavailable because of boiler feed pump problems.

July 25 - Boiler feed pump repair completed but Unit No.2 could not be in service before 6:00 p.m. because of a lack of water.

July 26 - More testing done on one modified CWF gun.

- CE and KDL people left site.

Aug. 6 - Unit No.2 on line to burn up the carbogel (CWF) in the bunker.

Aug. 7 - The water level in the Unit No.2 boiler drum went too high, which allowed wet steam to go to the turbine, and the unit tripped.

Aug. 12 - Inspection of turbine completed - the unit will be out of service for 4 weeks.

NRC Burner Test - CWF 4

Aug. 16 - All CWF in bunker burnt and piping flushed out.

Mid Aug. to late Sept. the new and larger N.R.C. gun was being manufactured.

OXCE Fuel Test - CWF 3

Aug. 29 - 62.4 tons of OXCE fuel unloaded from one rail tank car.

- 12 to 18 inches of settled CWF remained in the bottom of the car.

Aug. 30 - 24.6 tons of OXCE fuel burnt in Unit No. 1.

Sept. 6 - Remainder of OXCE fuel in the bunker burnt in Unit No. 1.

Sept. 9 - Agreed with OXCE - their fuel will have to be replaced before a meaningful test can be conducted in Unit No. 2.

Sept. 11 - Second car of OXCE fuel being unloaded.

Sept. 12 - Unit No. 1 out of service while the cooling water channel was being inspected.

Sept. 16 - Unit No. 1 in service burning OXCE fuel

Sept. 17 - Unit No. 1 out of service because the power supply to the tank farm was cut accidently by the Unit No. 3 construction.

NRC Burner Test - CWF 4		OXCE Fuel Test - CWF 3	
			- 3 rail cars released for return to OXCE.
		Sept. 18	- Unit No. 1 still out of service.
		Sept. 20	- Unit No. 1 in service but had to be shut down because of weather.
Sept. 25	- The carbogel in the three rail cars was tested in Chatham and found to be in good condition.	Sept. 25	- Unit No. 2 boiler was in service to dry out the new insulation on the turbine but had to be shut down due to a tube leak.
		Sept. 27	- Again the No. 2 boiler had to be shut down with a second tube leak.
Sept. 30	- NRC arrived in Chatham to test their new larger gun.	Sept. 30	- Repairs completed and Unit No. 2 in service to commission the turbine.
Oct. 1	- New NRC gun installed in Unit No. 1 boiler and some carbogel fuel unloaded.	Oct. 1	- C.E. Canada were told N.B. Power is ready to resume testing in Unit No. 2 with OXCE fuel.
	- The carbogel in the three rail cars was found to be settling.		
Oct. 2	- Preliminary testing done on the new NRC gun/atomizer.		
Oct. 3	- Unit No. 1 shut down because of a tube leak. N.R.C. left Chatham.		
		Oct.7	- OX-CE fuel (partly settled) was unsuccessfully tested in Unit No.2.

NRC Burner Test - CWF 4

OXCE Fuel Test - CWF 3

Oct.9/10 - Greg Dubien of OX-CE on site in Chatham to check fuel.

Oct.11 - Greg Dubien reported chemicals will be sent to Chatham to treat the OX-CE fuel in the Chatham bunker.

Oct.15-18 - OX-CE personnel on site to re-work their fuel and burn it in Unit No.2. There was a large amount of fall out and high opacity during the burning of the 70 tons of re-worked OX-CE fuel.

Oct.21 - OX-CE said they will not be sending new fuel to Chatham and will be re-working the fuel on site.

Oct.28 - OX-CE personnel returned to Chatham to re-work some of their fuel now on site ready for the burning test. All day was spent mixing one car of fuel to get the coal back into suspension.

Oct.29 - One rail car of OXCE fuel was unloaded into the in-plant storage bunker and new chemicals added.

NRC Burner Test - CWF 4

OXCE Fuel Test - CWF 3

Oct.30 - Two CWF guns in-service burning OXCE fuel with support ignition. The opacity readings were high. - For 45 minutes one CWF gun was run successfully with steam atomization before the gun plugged with fuel that had dried in the gun and atomizer tip.

Oct.31 - After operating for some time three CWF guns were in-service with stable fires burning OXCE fuel with no ignitors, and one heavy fuel oil gun at half load. The opacity reading at the meter was close to 50%,* after the burners had settled down. Therefore it was concluded there was no way four CWF guns at full, without support ignition, could be in-service with an acceptable opacity level in this unit.

*Note:
With Unit No. 1 boiler fans in Operation this opacity would be reduced to 37% at the discharge to boiler stack.

Nov.1 - Unit No. 2 in-service with two heavy oil guns at half load, and two CWF guns with OXCE fuel at full load and light oil

NRC Burner Test - CWF 4	OXCE Fuel Test - CWF 3
	ignitors to burn out the remaining OXCE fuel in the in-plant storage bunker. Good stable fires were obtained (with support ignition). - The one empty and two full rail cars of settled OXCE fuel were returned to OXCE Fuel Co., in Jacksonville, Florida. - This completed the test program for the "OXCE" fuel and new "CE" burners.
Nov.4 - Work started on remixing the three rail cars of carbogel fuel in Chatham, and getting ready for the retesting of the larger NRC - CWF - Guns.	

1

CANADA

COMBUSTION ENGINEERING - SUPERHEATER LTD
99 BANK STREET OTTAWA CANADA K1P 6C5
PHONE 613-560-4545 CABLE SUPERHEAT OTTAWA
TELEX 053-3394

File: CWF 9 Chatham
Coal/Water Burner Development
OXCE TEST - REPORT
Date: November 18, 1985

New Brunswick Electric Power Commission
515 King Street
Fredericton, N. B.

Attention: Mr. M. R. Thanisch

OXCE Coal Water Fuel Burn Test
Chatham Unit #2

Dear Mr. Thanisch

This letter summarizes the above captioned testing which took place during the week of October 28, 1985. The objective of the test was to demonstrate MCR Operation on resuspended OXCE CWF.

While this objective was not in fact ultimately achieved, the test can be termed a qualified success. In sum, stable combustion was demonstrated and the attainment of MCR was prevented only by the lack of an effective particulate collection system combined with the imposition of opacity limits stricter than those permissible under the variance in effect during previous testing.

Preparations for the test burn began 2 days prior to firing. Three (3) rail cars of OXCE CWF, prepared at the Jacksonville plant, were on site. The fuel had been produced in the Fall of 1984. The fuel, being nearly one year old, had settled and required re-suspension. The coal was re-entrained by air-lancing the hard pack at the bottom of the first rail car and adding a dispersant to promote re-entrainment. The re-suspended CWM was then transferred from the first rail car to the plant's storage tank. Constant agitation via the storage tank mixer and recirculation via the fuel system pumps was required as the treated fuel was not a stable mixture and rapidly settled when stagnant. Only one rail car (approximately 70 tons of CWF) was transferred to the storage tank by the OXCE personnel on site (K. Peterson, M. Prieto).

Boiler operation began on Wednesday (10/30/85). Operation on Wednesday was delayed until late in the day because of circuit breaker failures, condenser vacuum problems, and the failure of the motorized high pressure heater by-pass valve. The H.P. heater by-pass valve was never repaired, and ultimately the boiler was operated with the H.P. heater in a 100% by-pass mode. This limited maximum electrical output of the plant to 11-15 MWe; the plant is capable of 22 MWE output. The boiler could, however, be operated near MCR (280 x 10^6 Btu/hr heat input) in the by-pass mode; the electrical output at any given test condition does not accurately reflect the boiler heat input in this mode of operation.

Stack opacity was defined to be the limiting factor for operation on CWF. The legal limit for stack opacity is 20%. Operating the fans in the Foster Wheeler Unit 1 can effectively "dilute" Unit 2 stack opacity. Unit 1 air flow enters the stack downstream of the plant opacity monitor. NB Power has calculated a dilution. Monitor readings on the order of 30-35% opacity were determined to be within the 20% opacity limitation. Note that Unit 2 is a 1955 design boiler with only gross particulate removal.

The following previous firing tests on carbogel CWF, the burners in Unit #2 were reworked to increase burner auxiliary air velocity and produce an improved furnace fireball configuration.

The boiler was brought on line with three (3) Bunker "C" guns in operation at partial load on "A", "C", and "D" corners. Stack opacity was 12% with these three oil guns in service at 11 MWe. The burners, when fired on oil, operate with 3.5" W.G. on the primary air swirler.

A CWF gun (35° atomizer) was then installed in "B" corner's; KDL personnel had fully instrumented that corner during previous test work. "B" burner was operated at full load (70 x 10^0 Btu/hr heat input) using initial set point conditions defined during our brief period of operation last July (see #1 attached).

With the ignitor on, one CWF gun in service increased opacity to 35%. When the ignitor was extinguished, stack opacity increased to 60-70%. Due to high stack opacity optimization of atomizer position and swirler pressure had to be carried out with the ignitor in service. Atomizing air pressure was reduced to 150 psig (A/F = 0.14), bringing about an increase in opacity to approximately 50%. A return to the original atomizing air pressure (185 psig, A/F = 0.20), and a reduction in fuel flow rate to 80% of full load resulted in an opacity level of 25%, however, a quantum improvement in flame appearance was not realized.

Note that throughout this optimization, visual observations were made both in the ash pit and in the boiler's convective sections. Few "fireflies" were observed, with negligible carry-over into the convective section. However, a small but steady stream of fairly large (1/4" - 1"), non-burning particles were falling onto the ash pit floor,

which, after a few seconds would ignite and burn on the floor. The population or size of this agglomerates did not appear to change throughout this phase of testing. A sample of this material was collected for future analysis, the material is slight, sintered and has a high carbon content (83%).

Steam atomization was tried next in an attempt to improve flame stability. Initially, steam pressure was held equivalent to the atomizing air pressure previously tried (185 - 190 psig at S/F = 0.17). This resulted in a substantially higher population of non-burning particles falling to the ash pit floor as compared with air atomization.

At this point a steam pressure relief valve failed in the system, limiting available steam pressure at the gun to 150 psig (steam/fuel mass flow ratio = 0.12). Opacity was 35% with the ignitor extinguished, the flame front was approximately 2 feet off the burner quarl. The quantity and size of the agglomerates falling into the ash pit was similar to that observed in the previous test. Few fireflies were noted in the convective section.

After 40 minutes of operation with steam atomization, the CWF atomizer and gun plugged. The atomizer was solidly plugged, the gun was plugged at both ends. Steam temperature was 448°F, this obviously promoted CWF drying and eventual fouling.

Testing was curtailed at this time because the plant had imposed an 8:00 PM test cut-off time. Several of the ignitors also required electrical repair work which was schedule for the night shift crew.

Test Day 10/31/85

The boiler was brought on line late morning (plant equipment problems) and fired at maximum rate on Bunker "C" oil in order to provide the hottest environment possible for CWF firing. The high-pressure heater by-pass was un-repairable, so electrical output was again limited to 12 MWe.

The narrow angle (25°) CWF atomizers were utilized throughout the day. CWF guns were brought on line progressively, with C corner first, then A (the opposite corner), and finally B. Test conditions with three CWF guns in service are delineated in #1 attached. Movies were taken as each gun was put into service. The ignitors remained in operation throughout, however, flame stability had improved quantitatively with the 25° atomizers in service. Opacity increased with increased slurry usage. One CWF gun and three oil guns produced 27% opacity; two CWF guns and two oil guns produced 38% opacity, and three CWF guns and one oil gun produced about 64% opacity. Plant management indicated that operation at this opacity level was unacceptable, the stack had a trace black appearance. Increasing total excess air to the furnace decreased opacity to approximately 55% (trace brown stack).

The ignitors were progressively taken out of service, opacity decreased to approximately 50% (trace brown stack). The CWF flames were attached and appeared to be as stable as has ever been achieved throughout the Unit 2 test program. Firefly production was minimal, however, a steady stream of agglomerates fell to the floor, igniting and burning as the day before. An ash pit sample was removed for future analysis. The sample again contained about 83% carbon. With three CWF guns in service, a dense cloud of burning fine coal was observed in the ash pit, fine coal was observed to be burning in the convection section as well.

The boiler was operated in this configuration for about 45 minutes and a movie taken, however, the boiler operators suddenly realized that they had accidentally depleted the plant's Bunker "C" day tank, and shut down the unit.

Subsequent analysis of the movies taken indicated that the burner in "C" corner had severe instabilities; this could potentially be attributable to the "C" corner ignitor which was cycling intermittently, even when switched off by the operator.

Test Day 11/1/85

It was clear from the previous day's operation that Unit 2 could not meet required opacity levels with 3 CWF guns in service. Joint agreement was reached between the OXCE personnel on site and M. Thanisch of N.B. Power that the remaining 35 tons of CWF in the bunker be incinerated with 2 CWF guns in service, with the remaining two tank cars to be shipped back to the U.S.

Unit 2 was brought on line and corners C and A brought into service on CWF. Opacity was approximately 35%, however, oil fire fluctuations were noted to be generating high (60%) opacity levels on occasion. The boiler operators attributed this to dirty oil atomizers.

Operation continued in this mode throughout the day, the OXCE fuel was incinerated by day's end.

Summary

Unburned CWF agglomerates fell to the furnace floor throughout testing. The qualitative nature of the Chatham testing doesn't lend itself to offering an explanation for this phenomena. It may be a function of re-suspended CWF quality, additive interaction upon heating, or burner/furnace incompatibilities where fuel droplets may be periodically collecting and falling off the furnace walls. No fuel spray deposition on the burner quarls was observable.

The narrow angle CWF atomizers are better suited to the new burners installed in Chatham than the wider angle atomizers used previously.

To allow operation of more than 2 CWF guns in Chatham #2, more effective particulate collection is required.

Full atomizer throughput was achieved with both air and steam atomization. (The pluggage which occurred after about 40 minutes of operation on steam is a problem which minor design changes to the gun itself will correct.) The flame in each case appeared stable and of good quality.

Yours truly

M. Ward
Research & Development

MW:ej

c.c. D. M. Rankin
S. A. Morrison
R. Feindel
D. Cook

6

CONFIDENTIAL

#1

TEST CONDITIONS
CHATHAM/OXCE CWF BURN

1) CWF ("B" corner) Bunker "C" (A, C, D corners)

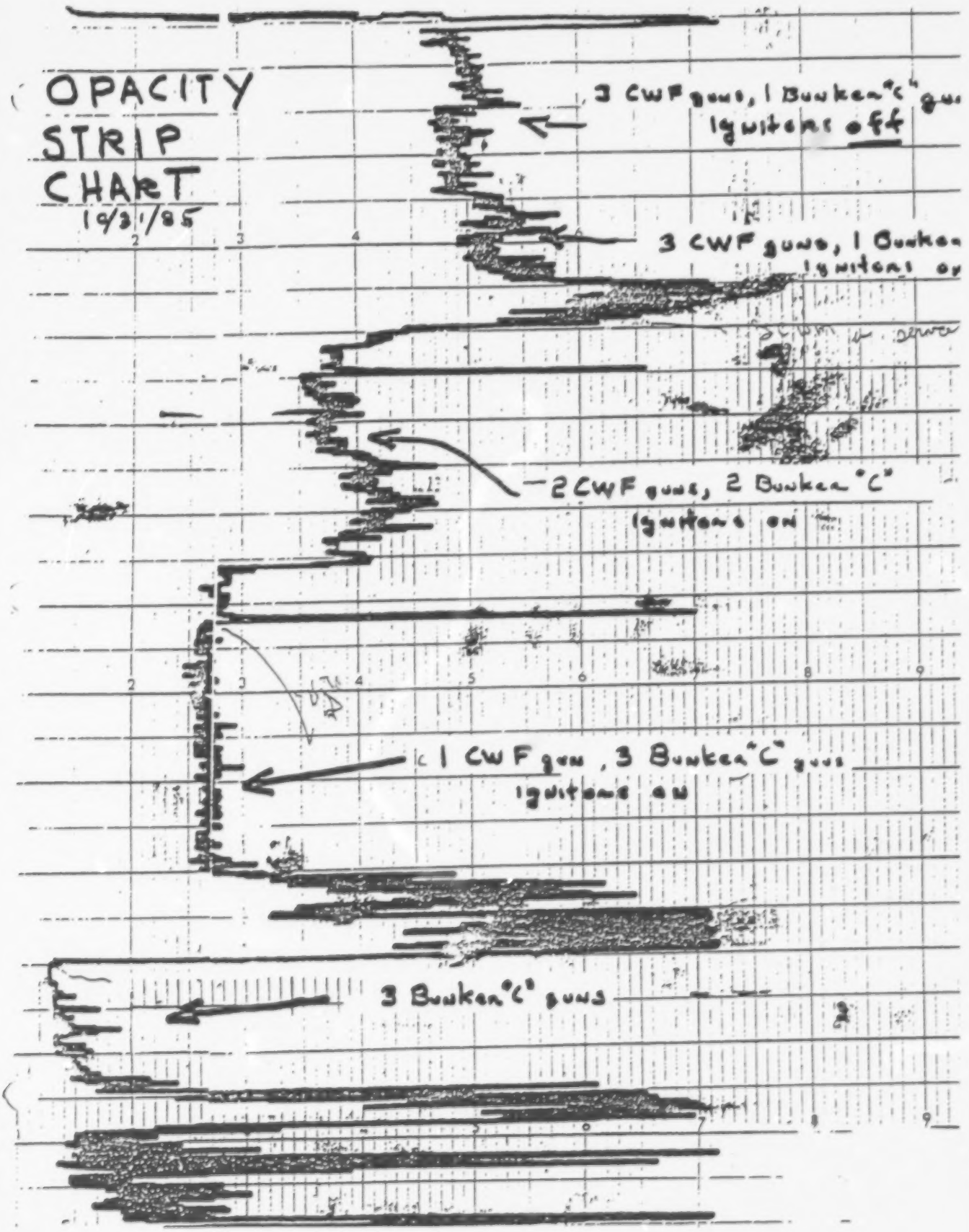
Ignitor On

CWF Flow = 116 #/min
CWF Temp. = 60°F
CWF Pressure at Gun = 175 psig
CWF atomizer = 35°
CWF Gun Location = 9" (Block to flange)
Aux Air Compartment Dampers = 100% open (setting 5)
Atom. Air Pressure = 185 psig
A/F = 0.16
Aux. Air Temp. = 438°F
Swirler Air Pressure = 6" W.G.
Swirler Air Temp. = 400°F (erratic T.C.)

2) CWF ("A", "B", "C" corners) Bunker "C" ("D" corner)

Ignitors Off ("C" corner ignitor erratic)

	"B" Corner	"A" Corner"	"C" Corner
CWF Flow (#/min)	90	—	—
CWF Temp. (F°)	60	—	—
CWF Pressure at Gun	155	162	162
CWF Atomizer	25°	25°	25°
CWF Gun Location (block to flange)	10"	10"	10"
Aux. Air Dampers	100% Open	100% Open	100% Open
Atom. Air Press. (psig)	185	178	180
A/F	0.22	—	—
Aux. Air Temp (F°)	422	—	—
Swirler Air Temp (F°)	400	—	—
Swirler Air Press. ("W.G"	6.3	6.7	6.0


OPACITY
STRIP
CHART
10/31/85
3 CWF guns, 1 Bunker "C" gun
ignitors off
3 CWF guns, 1 Bunker
ignitors on
2 CWF guns, 2 Bunker "C"
ignitors on
1 CWF gun, 3 Bunker "C" guns
ignitors on
3 Bunker "C" guns

Interoffice Correspondence

OXCE FUEL COMPANY

cc'd MIKE TRAMBLEY
NBP 3/18/86

R. Feindel
C-E, Ottawa

OXCE FUEL ANALYSES
CHATHAM DEMONSTRATION

G. W. Dubin

cc: R. C. LaFlesh
W. G. Rakitsky
Route/File/GWD

February 12, 1986

At your request, we have reviewed the fuel test data on the OXCE CWF which was shipped to, and subsequently reconstituted at, New Brunswick Power's Chatham Generating Station. The following data and comments are provided for your use in the generation of any reports or technical papers related to this project.

On June 24th and 25th, 1985, six rail tank cars were filled with approximately 15,400 gallons each of OXCE coal-water fuel. This fuel was manufactured in advance of this loading date, in anticipation of an earlier test date at Chatham.

Fuel properties common to the six rail cars were as follows:

Higher Heating Value

10320 Btu/lb (24.0 MJ/KG)
104300 Btu/gallon (29.1 MJ/Liter)

Sulfur (dry basis)	0.73%
Ash (dry basis)	5.42%
Volatile Matter (dry basis)	32.9%

Fuel test data specific to each individual rail car is provided in the attached table.

Three of the tank cars were utilized for short fuel burns after their arrival in mid-July through October. Due to fuel deterioration over time, it was decided to test chemical reconstitution of the fuel in mid-October which proved successful.

Due to the success of the reconstitution, it was decided to conduct an abbreviated burner test program utilizing fuel which would be reconstituted from the remaining three rail tank cars. The following describes the reconstitution of that fuel.

At Chatham, the three OXCE railcars of CWF had been moved to the unloading dock and Chatham personnel were in the process of mixing the coal-water fuel in car no. 15019 by air lancing when OXCE personnel arrived on Monday, October 28. The CWF had segregated into three distinct layers; a surface water layer, a soft-fluid partially flocculated central mass, comprising the major part of the total volume, and a sedimented hard pack. The relative layers had not changed appreciably from that as previously observed several weeks before. A total of about 20 hours of air lancing was required before the major part of the coal-water mixture had attained a solids loading adequate for the burn test. Composition and viscosity of the mixture as air lancing progressed is shown below:

Air Lancing Time-Hours	Solids Wt %	Viscosity cp	Density g/cc
4	65.5	440	1.19
12	66.9	550	1.19
18	67.7	560	1.19
20	68.3	750	1.20

Unloading and transfer of the coal-water mixture was accomplished by pressurizing the tank car with air to about 30 psig and transfer of the mixture through a four inch pipeline to the feed bunker. About 72.3 tons of CWF was transferred from the tank to the bunker representing about 90% of the material in the railcar.

CWF Reconstitution:

A dosage test with a sample of mixture from the fuel bunker indicated that a small amount of dispersant was sufficient to lower the viscosity of the CWF to a value the plant injection equipment could conveniently handle (400-500 cp). Sufficient dispersant was slowly added to the fuel bunker at the recirculation port. The mixture was then circulated in the bunker for about 16 hours. Following this circulation, analyses of samples of CWF from both the burner front and top of the bunker indicated a well homogenized fluid mixture suitable for CWF burner testing.

	Burner Front	Top of Fuel Bunker
Viscosity, (cp)	400	450
Solids, wt%	68.11	68.11
Density, g/cc	1.19	1.19

Please let me know if any further information is required.

G. W. Dubin

GWD/mlp
Attachment

OXCE CWF PROPERTIES
GATX RAIL CARS FOR NEW BRUNSWICK POWER
LOADED JUNE 24 & 25, 1985

	RAIL CAR NUMBER					
	94648	94645	98051	15017	15018	15019
Specific Gravity	1.191	1.199	1.194	1.189	1.181	1.189
% Solids	69.53	69.59	69.62	69.52	69.52	69.63
Viscosity (Haake)						
110 sec^{-1}	1409	1612	1607	1546	1590	1656
75 sec^{-1}	1494	1693	1693	1610	1680	1726
2.2 sec^{-1}	3687	4077	4077	3906	3968	4248
1.1 sec^{-1}	4512	5166	5041	5104	5166	5135
75 sec^{-1}*	1545	1771	1771	1719	1687	1874

* After 24 hours stagnant in rail car

COMBUSTION ENGINEERING

March 14, 1986

New Brunswick Electric Power Commission
515 King Street
Fredericton, N. B.
E3B 4X1

Attention: Mr. D. M. Rankin

Re: OXCE Coal Water Fuel Burn Test
Chatham Unit #2
OXCE Fuel Analyses

Dear Mr. Rankin

As per your telephone request to me March 14, 1986, following is a report on the OXCE fuel analysis for the OXCE fuel used in the October 30 - November 1, 1985 OXCE Coal Water Fuel Burn Test at Chatham Unit #2.

With regard to your request for the film made of the OXCE fuel firing, we do not intend to release this film as it is proprietary in nature and not for public disclosure.

On June 24 and 25, 1985, six rail tank cars were filled with approximately 15,400 gallons each of OXCE coal water fuel. This fuel was manufactured in advance of this loading date, in anticipation of an earlier test date at Chatham.

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Three of the tank cars were utilized for short fuel burns after their arrival in mid-July through October. Due to fuel deterioration over time, it was decided to test chemical reconstitution of the fuel in mid-October which proved successful.

C-E Canada Power Systems
Combustion Engineering Canada Inc.
99 Bank Street
Ottawa, Ontario
K1P 6C5
(613) 560-4545
Telex: 0533394
Telefax: (613) 560-4494

Due to the success of the reconstitution, it was decided to conduct an abbreviated burner test program utilizing fuel which would be reconstituted from the remaining three rail tank cars. The following describes the reconstitution of that fuel by OXCE personnel.

At Chatham, the three OXCE rail cars of CWF had been moved to the unloading dock and Chatham personnel were in the process of mixing the coal-water fuel in car no. 15019 by air lancing when OXCE personnel arrived on Monday, October 28. The CWF had segregated into three distinct layers; a surface water layer, a soft-fluid partially flocculated central mass, comprising the major part of the total volume, and a sedimented hard pack. The relative layers had not changed appreciably from that as previously observed several weeks before. A total of about 20 hours of air lancing was required before the major part of the coal-water mixture had attained a solids loading adequate for the burn test. Composition and viscosity of the mixture as air lancing progressed is shown below:

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	Burner Front	Top of Fuel Bunker
Viscosity, (cp)	400	450
Solids, wt%	68.11	68.11
Density, g/cc	1.19	1.19

Please let me know if any further information is required.

Yours truly

S. A. Morrison
Director Research & Development

SAM:ej

c.c. R. Feindel/D. Cook
M. Thanisch, NBEPC

OXCE CWF PROPERTIES
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LOADED JUNE 24 & 25, 1985

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1.1 sec^{-1}	4512	5166	5041	5104	5166	5135
75 sec^{-1}*	1545	1771	1771	1719	1687	1874

* After 24 hours stagnant in rail car

NOTE: Please see that the agreement outlined in item #3 of S. Morrison's July 9, 1985 telex and letter (attached) to your D. Rankin is followed before release of any reports. I would also like a copy of the report you are presently working on plus a copy of the full final report on the Carbogel firing in Unit #2.

Sincerely Yours

D Cook.

D. Cook
Research & Development

DC:ej
Attach:

c.c. S. Morrison/R. Feindel
A. Kokkinos (Windsor 9005-0301) w/a

COMBUSTION ENGINEERING

File: CWF 3-4.2 Chatham
Coal/Water Burner Development
CXCE FUEL TEST
Date: 24 MARCH 86

BOILER MODIFICATIONS

March 24, 1986

New Brunswick Electric Power Commission
515 King St., (P.O. Box 2000)
Fredericton, N. B.
E3B 4X1

Attention: Kenneth Brown
Engineering Department

Re: Your March 3, 1986 letter w.r.t. - modifications on Chatham Unit #2 prior to OXCE Fuel firing.

Enclosed are three sketches of the Chatham windbox arrangement used to fire CWF. Sketches I and II are the original windbox layouts. Sketch III shows the windbox modifications performed prior to the OXCE fuel tests, these modifications are shown as items (1) - (4) on the sketch and are explained below;

1) The four auxiliary air compartments in each corner were modified to increase the exit velocity of the secondary air to improve fireball aerodynamics.

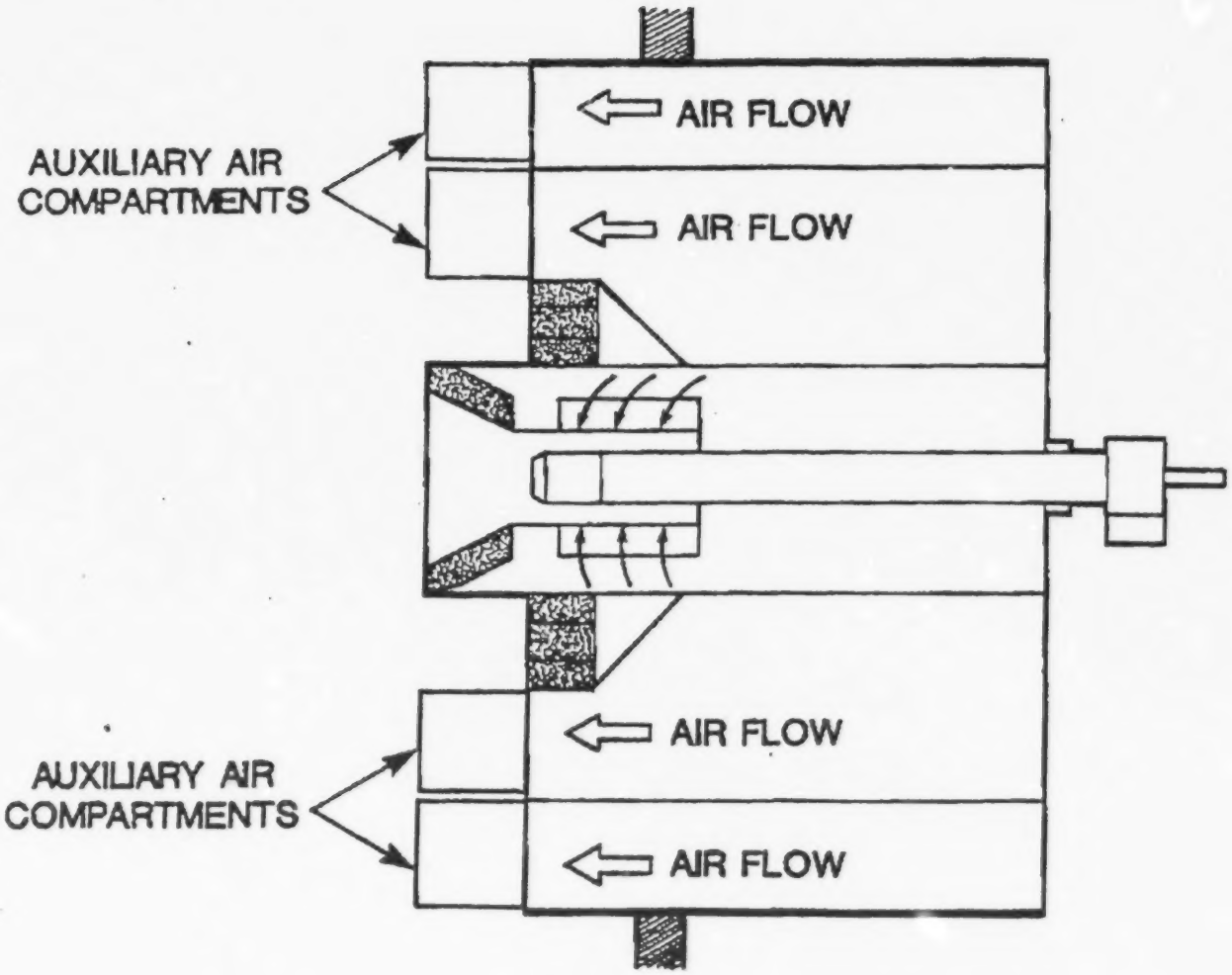
2) The exit velocity of the burner compartment was decreased to improve flame attachment.

3) The primary air swirler was replaced with a high efficiency design to reduce fan head requirements.

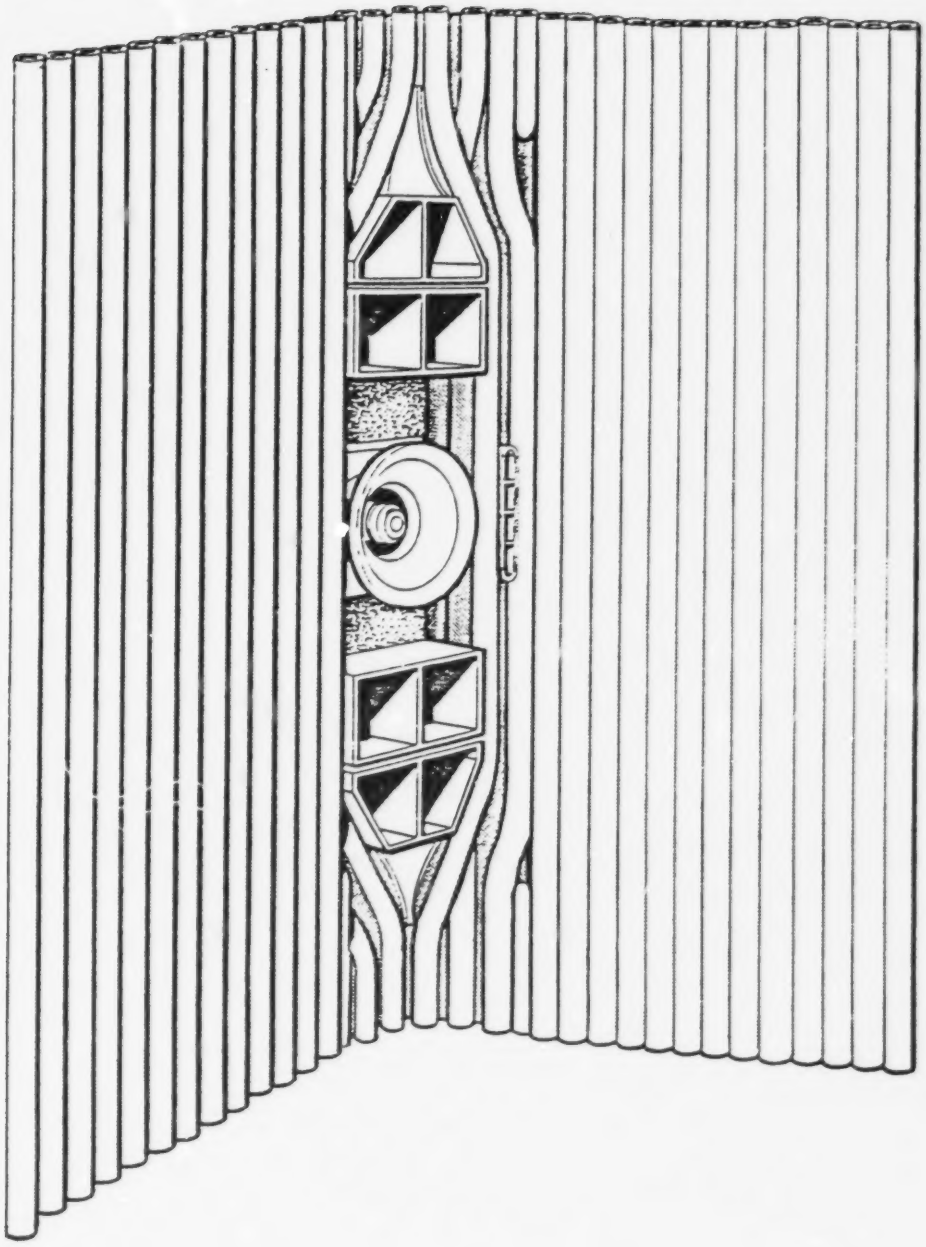
4) The side pilot ignitor was relocated to just below the burner compartment to avoid interference of the ignitor flame and the bucket.

The performance of the new style burner is described more fully in the paper "Comparison of the Performance of a Cross section of Commercial CWF Burners", presented at the "7th International Symposium of CWF in New Orleans" (see attached).

C-E Canada Power Systems
Combustion Engineering Canada Inc.
99 Bank Street
Ottawa, Ontario
K1P 6C5
(613) 560-4545
Telex: 0533394
Telefax: (613) 560-4494

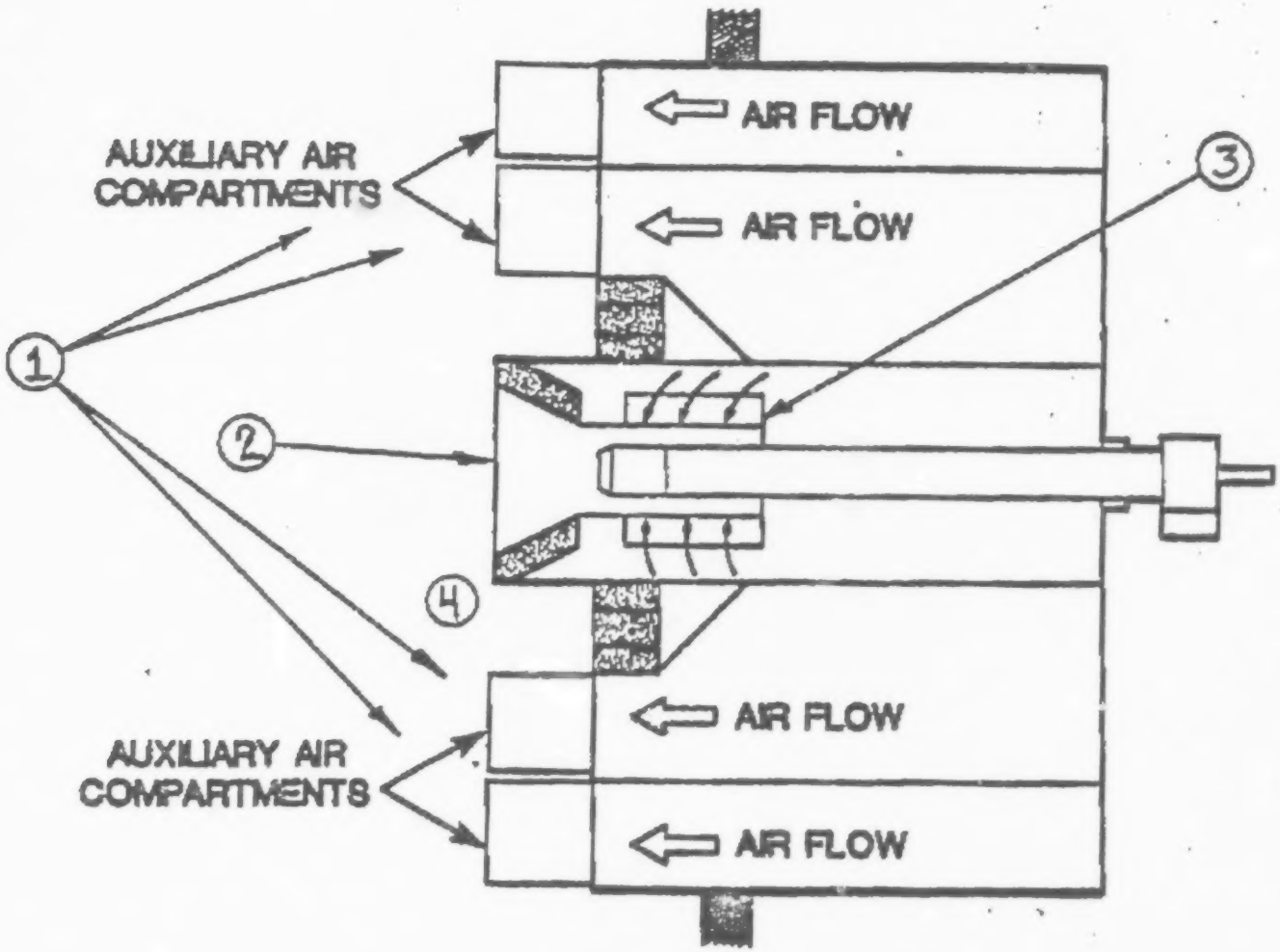

AIR FLOW
AUXILIARY AIR COMPARTMENTS
AIR FLOW
AIR FLOW
AUXILIARY AIR COMPARTMENTS
AIR FLOW

SKETCH Nº 1



SKETCH. Nº 2

CHATHAM UNIT #2 MODIFICATIONS



Chatham #2 Windbox with Aux. Air Buckets

SKETCH Nº3

COMBUSTION ENGINEERING

File: CWF 3.6.1 Chatham
Coal Water Burner Development
OXCE FUEL TEST BURN
Date: 24 April 86

April 24, 1986

COURIER

New Brunswick Electric Power Commission
515 King Street
Fredericton, New Brunswick
E3B 4X1

Attention: Mr. D. Rankin

Re: OXCE Coal Water Fuel Burn Test
Chatham Unit #2

Dear Mr. Rankin

As per our April 18, 1986 telex please find enclosed the movie film taken by KDL during the OXCE test burn in Chatham Unit 2 on October 31, 1985. The orientation of the furnace in the film is shown in Figure 1.

The film shows the following:

1) Several sequences showing three corners on oil (A,B,D) and C corners on CWF.

2) View of ashpit during above condition. Note that this image is inverted by camera lens.

3) Several sequences of corners B and D on oil and corners A and C on CWF.

4) View of ashpit during condition above (3).

We do hope that this material will allow you to complete your final report on the above work.

Yours truly

D Cook for

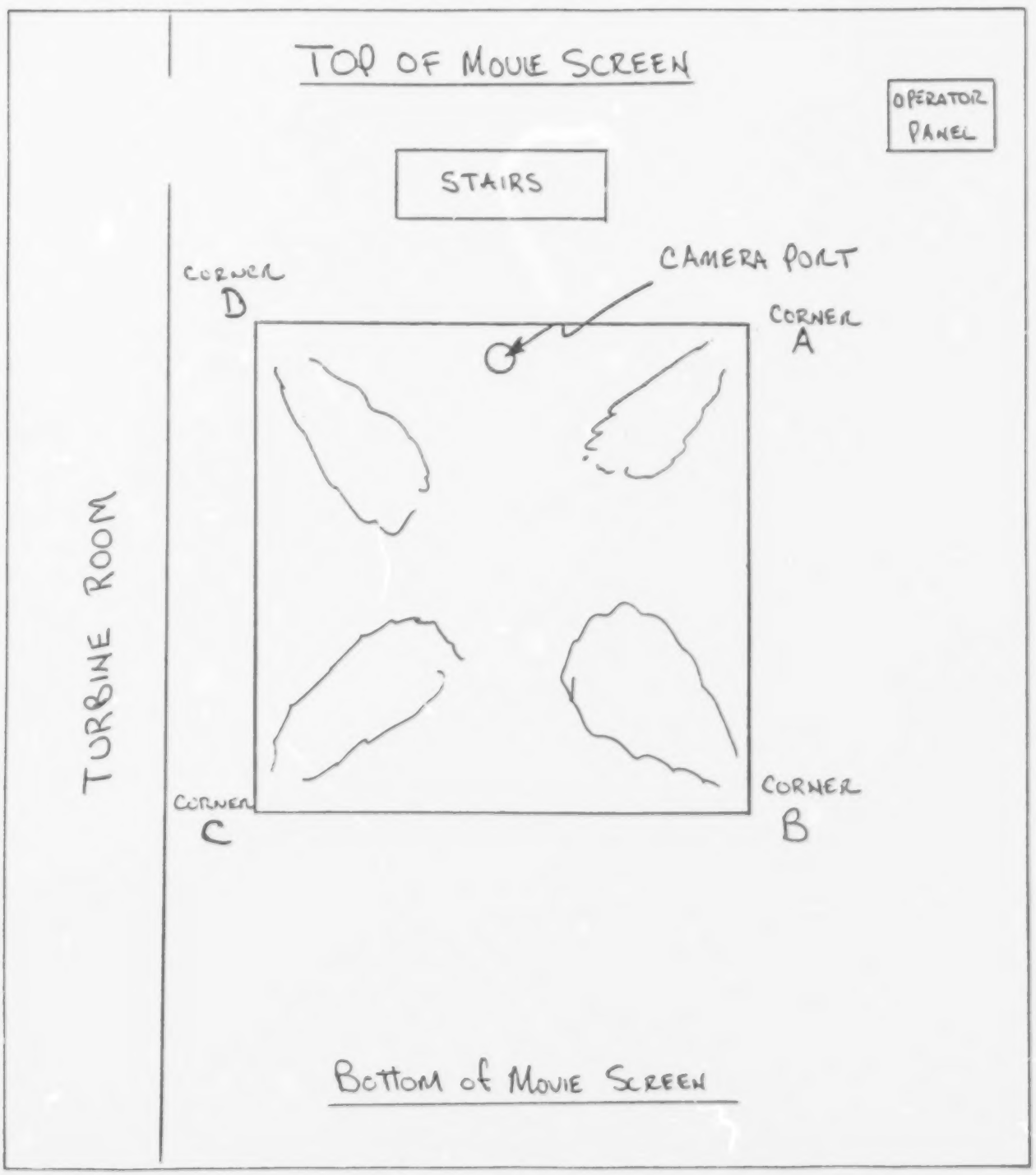
R. Feindel
New Product Supervisor

RF:ej
Encl.

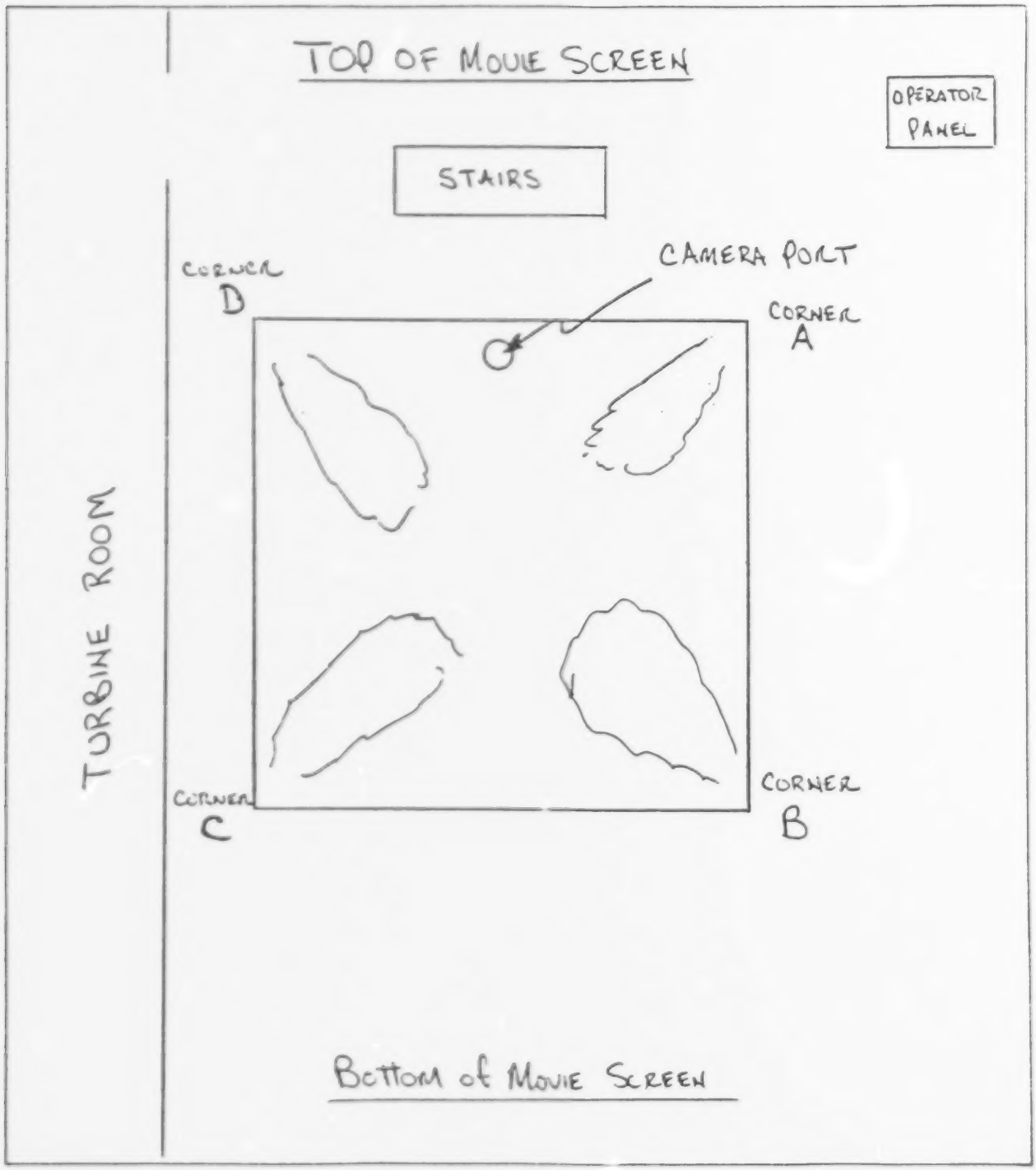
c.c. S. A. Morrison
D. Cook
M. Rini (KDL, Windsor)

C-E Canada Power Systems
Combustion Engineering Canada Inc.
99 Bank Street
Ottawa, Ontario
K1P 6C5
(613) 560-4545
Telex: 0533394
Telefax: (613) 560-4494

CHATHAM FILM ORIENTATION



CHATHAM FILM ORIENTATION



MEASURED & CORRECTED OPACITY

CHATHAM THERMAL GENERATING STATION

OCTOBER 1985

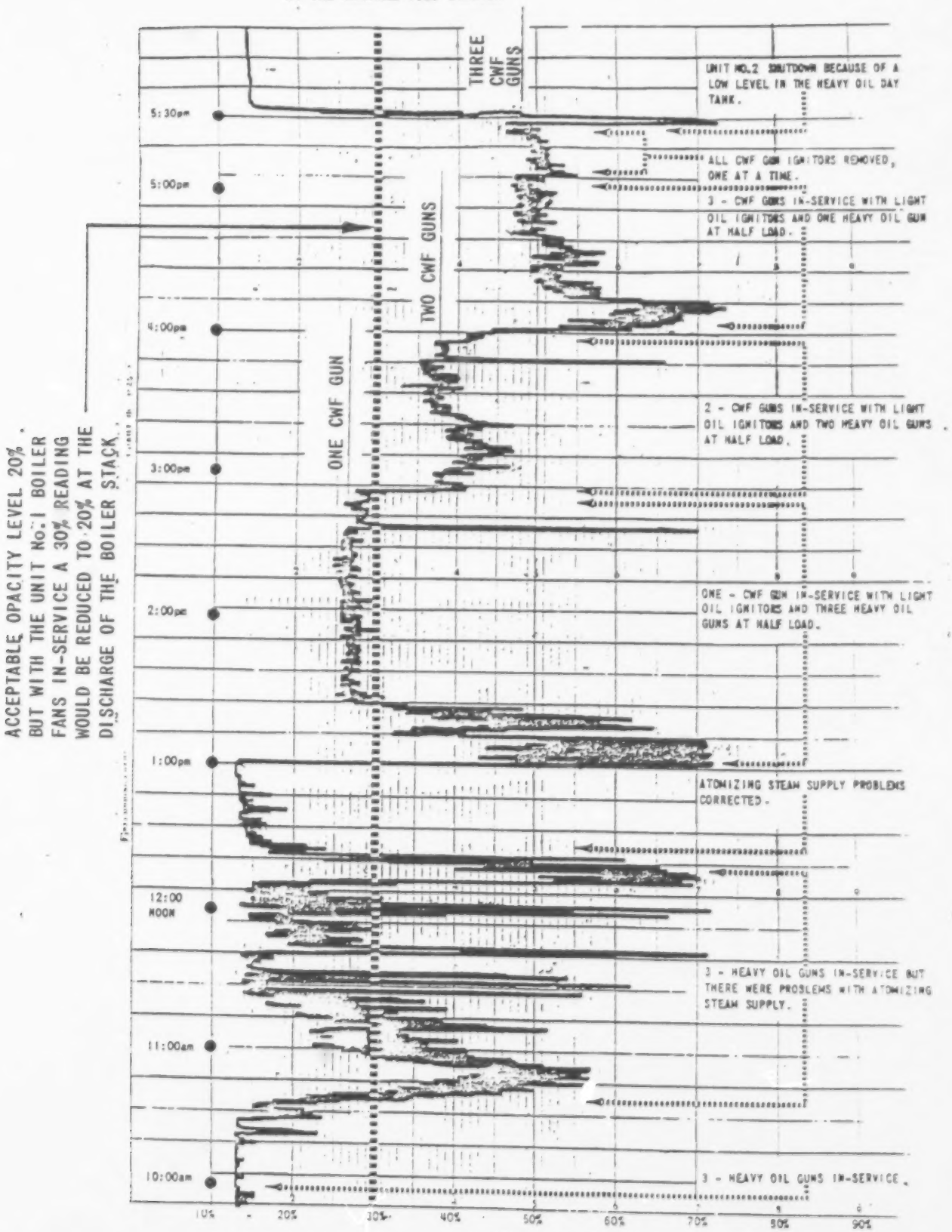
UNIT N°1 (IN SERVICE)

Recorder Exit Opacity With Only Unit N°1 Boiler in Service.	Calculated Exit Opacity With Unit N°2 Boiler Fans in Service.
50%	30%
45%	27%
40%	22%
35%	20%
30%	17%

UNIT N°2 (IN SERVICE)

Recorded Exit Opacity With Only Unit N°2 Boiler in Service.	Calculated Exit Opacity With Unit N°1 Boiler Fans in Service.
50%	37%
40%	28%
30%	20%
20%	13%
10%	7%

OPACITY READING TAKEN ON 31st OCTOBER 1985 WHILE "OXCE" FUEL AND "CE" BURNERS WERE BEING TESTED IN UNIT No. 2 AT THE CHATHAM T.G. STATION


THREE CWF GUNS
TWO CWF GUNS
ONE CWF GUN
UNIT NO.2 SHUTDOWN BECAUSE OF A LOW LEVEL IN THE HEAVY OIL DAY TANK.
ALL CWF GUN IGNITORS REMOVED, ONE AT A TIME.
3 - CWF GUNS IN-SERVICE WITH LIGHT OIL IGNITORS AND ONE HEAVY OIL GUN AT HALF LOAD.
2 - CWF GUNS IN-SERVICE WITH LIGHT OIL IGNITORS AND TWO HEAVY OIL GUNS AT HALF LOAD.
ONE - CWF GUN IN-SERVICE WITH LIGHT OIL IGNITORS AND THREE HEAVY OIL GUNS AT HALF LOAD.
ATOMIZING STEAM SUPPLY PROBLEMS CORRECTED.
3 - HEAVY OIL GUNS IN-SERVICE BUT THERE WERE PROBLEMS WITH ATOMIZING STEAM SUPPLY.
3 - HEAVY OIL GUNS IN-SERVICE.
5:30pm
5:00pm
4:00pm
3:00pm
2:00pm
1:00pm
12:00 NOON
11:00am
10:00am
10%
20%
30%
40%
50%
60%
70%
80%
90%
OPACITY READING

ACCEPTABLE OPACITY LEVEL 20%. BUT WITH THE UNIT No.1 BOILER FANS IN-SERVICE A 30% READING WOULD BE REDUCED TO 20% AT THE DISCHARGE OF THE BOILER STACK.

TAKEN WITH THE METER LOCATED IN THE 90° ELBOW AT DISCHARGE OF THE UNIT No. 2 BOILER I.D.-FAN

OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

APPENDIX B

COST SUMMARIES

PROGRESS CLAIM NO.	PERIOD COVERED
1	- May 1985
2	- June 1985
3	- July 1985
4	- August 1985
5	- September 1985
6	- October 1985
7	- November 1985
8	- December 1985
9	- January 1986
10	- February and March 1986
11	- Hold-Back Release

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK
515 KING STREET, P.O.BOX 2000, FREDERICTON; CANADA N.B. E3B 4X1

DEPARTMENT OF SUPPLY & SERVICE
11C1 PLACE DU PORTAGE, PHASE III.
11 LAURIER STREET,
HULL; QUEBEC.
K1A 0S5

ATTN. Mr.DON FRASER
SCIENCE & PROFESSIONAL DIRECTORATE.

DATE : 85.AUGUST 19
PROGRESS CLAIM # : 01
PERIOD : MAY 1985

FILE # 155Q.23440-4-9299
CONTRACT # 05Q85 - 0001J

CANADA/NEW BRUNSWICK ELECTRIC POWER COMMISSION
CHATHAM OX-CE COLD-WATER FUEL
DEMONSTRATION #3
JOB # 671-44000

PAYMENT ITEM #	DESCPIPTION	TOTAL TO DATE	PREVIOUS CLAIM	CURRENT CLAIM BILLABLE COST	OVERHEAD & BURDEN %	OVERHEAD & BURDEN $	CURRENT CLAIM BILLABLE AMOUNT
1	Labour	1,040.34	0.00	770.62	35%	269.72	1,040.34
2	Travel & Living Allowance	0.00	0.00	0.00	15%	0.00	0.00
3	Consumable Material	0.00	0.00	0.00	15%	0.00	0.00
4	Direct charges	0.00	0.00	0.00	0%	0.00	0.00
5	Energy Credit	0.00	0.00	0.00	0%	0.00	0.00
	T O T A L : 100%	1,040.34	0.00	770.62		269.72	1,040.34
	LESS HOLD BACK 10%	104.03	0				104.03
	PROGRESS CLAIM 90%	$936.31	$0.00	THIS PROGRESS CLAIM :			$936.31

TERMS : NET 30 DAYS

C.C. Dr.Horace Whaley
CANMET, Energy Research Laboratories.EMR

DR : 164-005-21100-27100
CR : 671-000-44000-27100

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK
515 KING STREET, P.O.BOI 2000, FREDERICTON; CANADA N.B. E3B 4I1

DEPARTMENT OF SUPPLY & SERVICE
IICI PLACE DU PORTAGE, PHASE III.
II LAURIER STREET,
HULL; QUEBEC.
K1A 0S5

ATTN. Mr.DON FRASER
SCIENCE & PROFESSIONAL DIRECTORATE.

DATE : 85.AUGUST 1985
PROGRESS CLAIM # : 02
PERIOD : JUNE 1985

FILE # 155Q.23440-4-9299
CONTRACT # 0SQ85 - 0001J

CANADA/NEW BRUNSWICK ELECTRIC POWER COMMISSION
CHATHAM OX-CE COLD-WATER FUEL
DEMONSTRATION #3
JOB # 671-44000

PAYMENT ITEM #	DESCRIPTION	TOTAL TO DATE	PREVIOUS CLAIM	CURRENT CLAIM			
				BILLABLE COST	OVERHEAD & BURDEN %	$	BILLABLE AMOUNT
I	Labour	3,273.21	1,040.34	1,653.98	35%	578.89	2,232.87
2	Travel & Living Allowance	0.00	0.00	0.00	15%	0.00	0.00
3	Consumable Material	0.00	0.00	0.00	15%	0.00	0.00
4	Direct charges	0.00	0.00	0.00	0%	0.00	0.00
5	Energy Credit	0.00	0.00	0.00	0%	0.00	0.00
	T O T A L : 100%	3,273.21	1,040.34	1,653.98		578.89	2,232.87
	LESS HOLD BACK 10%	327.32	104.03				223.29
	PROGRESS CLAIM 90%	$2,945.89	$936.31	THIS PROGRESS CLAIM :			$2,009.58

TERMS : NET 30 DAYS

C. Dr.Horace Whaley
CANMET, Energy Research Laboratories.EMR

DR : 164-005-21100-27100
CR : 671-000-44000-27100

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

515 KING STREET, P.O.BOX 2000, FREDERICTON; CANADA N.B. E3B 4X1

DEPARTMENT OF SUPPLY & SERVICE
11C1 PLACE DU PORTAGE, PHASE III.
11 LAURIER STREET,
HULL; QUEBEC.
K1A 0S5

ATTN. Mr.DON FRASER
SCIENCE & PROFESSIONAL DIRECTORATE.

DATE : Sept.20.1985
PROGRESS CLAIM # : 03
PERIOD : JULY 1985

FILE # 155Q.23440-4-9299
CONTRACT # 0SQ85 - 00013

CANADA/NEW BRUNSWICK ELECTRIC POWER COMMISSION
CHATHAM OX-CE COLD-WATER FUEL
DEMONSTRATION #3
JOB # 671-44000

PAYMENT ITEM #	DESCRIPTION	TOTAL TO DATE	PREVIOUS CLAIM	CURREN CLAIM			
				BILLABLE COST	OVERHEAD & BURDEN %	OVERHEAD & BURDEN $	BILLABLE AMOUNT
1	Labour	5,937.99	3,273.21	1,973.91	35%	690.87	2,664.78
2	Travel & Living Allowance	0.00	0.00	0.00	15%	0.00	0.00
3	Consumable Material	572.18	0.00	497.55	15%	74.63	572.18
4	Direct charges	0.00	0.00	0.00	0%	0.00	0.00
5	Energy Credit	0.00	0.00	0.00	0%	0.00	0.00
	T O T A L : 100%	6,510.17	3,273.21	2,471.46		765.50	3,236.96
	LESS HOLD BACK 10%	$651.02	327.32				323.7
	PROGRESS CLAIM 90%	$5,859.15	$2,945.89	THIS PROGRESS CLAIM :			$2,913.26
						TERMS : NET 30 DAYS	

C.C. Dr.Horace Whaley
CANMET, Energy Research Laboratories.EMR

DF : 164-005-21100-27100
DF : 671-000-44000-27100

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

515 KING STREET, P.O.BOX 2000, FREDERICTON; CANADA N.B. E3B 4X1

DEPARTMENT OF SUPPLY & SERVICE
11C1 PLACE DU PORTAGE, PHASE III.
11 LAURIER STREET,
HULL; QUEBEC.
K1A 0S5

ATTN. Mr.DON FRASER
SCIENCE & PROFESSIONAL DIRECTORATE.

DATE : Sept.20.1985
PROGRESS CLAIM # : 04
PERIOD : August 1985

FILE # 1550.23440-4-9299
CONTRACT # OS285 - 0001I

CANADA/NEW BRUNSWICK ELECTRIC POWER COMMISSION
CHATHAM OX-CE COLD-WATER FUEL
DEMONSTRATION #3
JOB # 671-44000

PAYMENT ITEM #	DESCRIPTION	TOTAL TO DATE	PREVIOUS CLAIM	CURRENT CLAIM			
				BILLABLE COST	OVERHEAD & BURDEN %	$	BILLABLE AMOUNT
1	Labour	9,385.74	5,937.99	2,553.89	35%	893.86	3,447.75
2	Travel & Living Allowance	222.66	0.00	193.62	15%	29.04	222.66
3	Consumable Material	986.18	572.18	360.00	15%	54.00	414.00
4	Direct charges	5,823.50	0.00	5,823.50	0%	0.00	5,823.50
5	Energy Credit	(569.65)	0.00	(569.65)	0%	0.00	(569.65)
	T O T A L : 100%	15,848.43	6,510.17	8,361.36		976.90	9,338.26
	LESS HOLD BACK 10%	$1,584.85	651.02				933.83
	PROGRESS CLAIM 90%	$14,263.58	$5,859.15	THIS PROGRESS CLAIM :			$8,404.43

TERMS : NET 31 DAYS

C.C. Dr.Horace Khalek
DAMES, Energy Research Laboratories,EMR

OR : 164-605-2116-0710
OR : 671-000-44000-0710

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ENERGIE ELECTRIQUE DU NOUVEAU-BRUNSWICK

515 KING STREET, P.O.BOX 2000, FREDERICTON, CANADA N.B. E3B 4X1

DEPARTMENT OF SUPPLY & SERVICE
11C1 PLACE DU PORTAGE, PHASE III.
11 LAURIER STREET,
HULL; QUEBEC.
K1A 0S5

ATTN. Mr.DON FRASER
SCIENCE & PROFESSIONAL DIRECTORATE.

DATE : October.31.85
PROGRESS CLAIM # : 05
PERIOD : SEPTEMBER 85

FILE # 1SSB.23440-4-9299
CONTRACT # OSQ85 - 00013

CANADA/NEW BRUNSWICK ELECTRIC POWER COMMISSION
CHATHAM CX-CE COLD-WATER FUEL
DEMONSTRATION #3
JOB # 671-44000

PAYMENT ITEM #	DESCRIPTION	TOTAL TO DATE	PREVIOUS CLAIM	CURRENT CLAIM BILLABLE COST	OVERHEAD & BURDEN %	OVERHEAD & BURDEN $	CURRENT CLAIM BILLABLE AMOUNT
1	Labour	36,329.05	9,385.74	19,958.01	35%	6,985.30	26,943.31
2	Travel & Living Allowance	723.97	222.66	435.92	15%	65.39	501.31
3	Consumable Material	1,891.92	986.18	787.60	15%	118.14	905.74
4	Direct charges	22,073.98	5,823.50	16,250.48	0%	0.00	16,250.48
5	Energy Credit	(5,711.69)	(569.65)	(5,142.04)	0%	0.00	(5,142.04)
	T O T A L : 100%	55,307.23	15,848.43	32,289.97		7,168.83	39,458.80
	LESS HOLD BACK 10%	5,530.72	1,584.84				3,945.88
	PROGRESS CLAIM 90%	$49,776.51	$14,263.59	THIS PROGRESS CLAIM :			$35,512.92

TERMS : NET 30 DAYS

C.C. Dr.Horace Whaley
CANMET, Energy Research Laboratories.EMR

DR : 164-005-21100-27100
CR : 671-000-44000-27100

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

515 KING STREET, P.O.BOX 2000, FREDERICTON, CANADA N.B. E3B 4X1

DEPARTMENT OF SUPPLY & SERVICE
11C1 PLACE DU PORTAGE, PHASE III.
11 LAURIER STREET,
HULL; QUEBEC.
K1A 0S5

ATTN. Mr.JON FRASER
SCIENCE & PROFESSIONAL DIRECTORATE.

DATE : NOVEMBER 27 85
PROGRESS CLAIM # : 06
PERIOD : OCTOBER 1985

FILE # 1552.23440-4-9299
CONTRACT # 0SQ85 - 00013

CANADA/NEW BRUNSWICK ELECTRIC POWER COMMISSION
CHATHAM OX-CE COLD-WATER FUEL
DEMONSTRATION #3
JOB # 671-44000

PAYMENT ITEM #	DESCPIPTION	TOTAL TO DATE	PREVIOUS CLAIM	CURRENT CLAIM			
				BILLABLE COST	OVERHEAD & BURDEN %	$	BILLABLE AMOUNT
1	Labour	61,158.61	36,329.05	18,392.27	35%	6,437.29	24,829.56
2	Travel & Living Allowance	2,055.12	723.97	1,157.52	15%	173.63	1,331.15
3	Consumable Material	3,749.41	1,891.92	1,615.21	15%	242.28	1,857.49
4	Direct charges	47,964.71	22,073.98	25,890.73	0%	0.00	25,890.73
5	Energy Credit	(15,976.05)	(5,711.69)	(10,264.36)	0%	0.00	(10,264.36)
	T O T A L : 100%	98,951.80	55,307.23	36,791.37		6,853.20	43,644.57
	LESS HOLD BACK 10%	9,895.18	5,530.72				4,364.46
	PROGRESS CLAIM 90%	$89,056.62	$49,776.51	THIS PROGRESS CLAIM :			$39,280.11

TERMS : NET 30 DAYS

C.C. Dr.Horace Whaley
CANMET, Energy Research Laboratories.EMR

DR : 164-005-21100-27100
CR : 671-000-44000-27100

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

515 KING STREET, P.O.BOX 2000, FREDERICTON, CANADA N.B. E3B 4X1

DEPARTMENT OF SUPPLY & SERVICE
(c/o) PLACE DU PORTAGE, PHASE III.
11 LAURIER STREET,
HULL QUEBEC.
K1A 0S5

ATTN. Mr.DON FRASER
SCIENCE & PROFESSIONAL DIRECTORATE.

DATE : DECEMBER 20,85
PROGRESS CLAIM # : 07
PERIOD : NOVEMBER 85

FILE # 1550.23440-4-9299
CONTRACT # 05085 - 00010

CANADA/NEW BRUNSWICK ELECTRIC POWER COMMISSION
CHATHAM OX-DE COLD-WATER FUEL
DEMONSTRATION #3
JOB # 671-44000

PAYMENT ITEM #	DESCRIPTION	TOTAL TO DATE	PREVIOUS CLAIM	CURRENT CLAIM			
				BILLABLE COST	OVERHEAD & BURDEN %	$	BILLABLE AMOUNT
1	Labour	$7,200.82	$1,158.61	4,475.71	35%	1,566.50	$6,042.21
2	Travel & Living Allowance	2,460.78	2,055.12	352.75	15%	52.91	405.66
3	Consumable Material	5,054.35	3,749.41	1,134.73	15%	170.21	1,304.94
4	Direct charges	99,096.57	47,964.71	51,121.86	0%	0.00	51,121.86
5	Energy Credit	(15,976.05)	(15,976.05)	0.00	0%	0.00	0.00
	TOTAL : 100%	107,836.47	38,951.80	57,085.05		1,789.62	58,874.67
	LESS HOLD BACK 10%	10,783.65	3,895.18				5,887.47
	PROGRESS CLAIM 90%	$140,043.82	$89,056.62	THIS PROGRESS CLAIM :			$52,987.20

TERMS : NET 30 DAYS

Chief Scientific Officer
CANMET, Energy Research Laboratories Ltd

ID : 164-005-21100-0711
ID : 671-XXX-44000-0711

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

515 KING STREET, P.O.BOX 2000, FREDERICTON, CANADA N.B. E3B 4X1

DEPARTMENT OF SUPPLY & SERVICE
11C1 PLACE DU PORTAGE, PHASE III.
11 LAURIER STREET.
HULL; QUEBEC.
K1A 0S5

ATTN. Mr.DON FRASER
SCIENCE & PROFESSIONAL DIRECTORATE.

DATE : MAY 20,1986
PROGRESS CLAIM # : 10
PERIOD : FEB & MAR 86

FILE # 1550.23440-4-9299
CONTRACT # 0SQ85 - 00013

CANADA/NEW BRUNSWICK ELECTRIC POWER COMMISSION
CHATHAM OX-CE COLD-WATER FUEL
DEMONSTRATION #3
JOB # 671-44000

PAYMENT ITEM #	DESCRIPTION	TOTAL TO DATE	PREVIOUS CLAIM	CURRENT CLAIM			
				BILLABLE COST	OVERHEAD & BURDEN %	$	BILLABLE AMOUNT
1	Labour	72,037.27	69,011.26	2,241.49	35%	784.52	3,026.01
2	Travel & Living Allowance	2,710.62	2,710.62	0.00	15%	0.00	0.00
3	Consumable Material	6,283.14	6,283.14	0.00	15%	0.00	0.00
4	Direct charges	149,210.43	138,506.10	10,704.33	0%	0.00	10,704.33
5	Energy Credit	(15,976.05)	(15,976.05)	0.00	0%	0.00	0.00
	AMOUNT OVER CONTRACT VALUE/BILLING # 09		(535.07)			535.07	535.07
	T O T A L : 100%	214,265.41	200,000.00	12,945.82		1,319.59	14,265.41
	LESS HOLD BACK 10%	20,000.00	20,000.00				0.00
	PROGRESS CLAIM 90%	$194,265.41	$180,000.00	THIS PROGRESS CLAIM :			$14,265.41

TERMS : NET 30 DAYS

NOTICE: THIS IS THE FINAL INVOICE EXCEPT FOR THE HOLD BACK RELEASE.

C.C. Dr.Horace Whaley
CANMET, Energy Research Laboratories.EMR

DR : 164-005-21100-27100
CR : 671-000-44000-27100

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

515 KING STREET, P.O.BOX 2000, FREDERICTON, CANADA N.B. E3B 4X1

DEPARTMENT OF SUPPLY & SERVICE
11C1 PLACE DU PORTAGE, PHASE III.
11 LAURIER STREET.
HULL: QUEBEC.
K1A 0S5

ATTN. Mr.DON FRASER
SCIENCE & PROFESSIONAL DIRECTORATE.

DATE : MAY 20,1986
PROGRESS CLAIM # : 11
PERIOD : HOLDBACK RELEASE

FILE # 1550.23440-4-9299
CONTRACT # 0SQ85 - 00013

CANADA/NEW BRUNSWICK ELECTRIC POWER COMMISSION
CHATHAM OX-CE COLD-WATER FUEL
DEMONSTRATION #3
JOB # 671-44000

PAYMENT ITEM #	DESCRIPTION	TOTAL TO DATE	PREVIOUS CLAIM	CURRENT CLAIM BILLABLE COST	OVERHEAD & BURDEN %	OVERHEAD & BURDEN $	CURRENT CLAIM BILLABLE AMOUNT
1	Labour	72,037.27	72,037.27	0.00	35%	0.00	0.00
2	Travel & Living Allowance	2,710.62	2,710.62	0.00	15%	0.00	0.00
3	Consumable Material	6,283.14	6,283.14	0.00	15%	0.00	0.00
4	Direct charges	149,210.43	149,210.43	0.00	0%	0.00	0.00
5	Energy Credit	(15,976.05)	(15,976.05)	0.00	0%	0.00	0.00
	LESS BILLING # 10	(14,265.41)	(14,265.41)				
	T O T A L : 100%	200,000.00	200,000.00	0.00		0.00	0.00
	LESS HOLD BACK 10%	20,000.00	20,000.00	0.00		0.00	0.00
	RELEASE HOLD BACK :	(20,000.00)	0.00				20,000.00
	TOTAL	200,000.00	180,000.00	THIS CLAIM :			$20,000.00

NET 30 DAYS

C.C. Dr.Horace Whaley
CANMET, Energy Research Laboratories.EMR

DR : 164-005-21100-27100
CR : 671-000-44000-27100

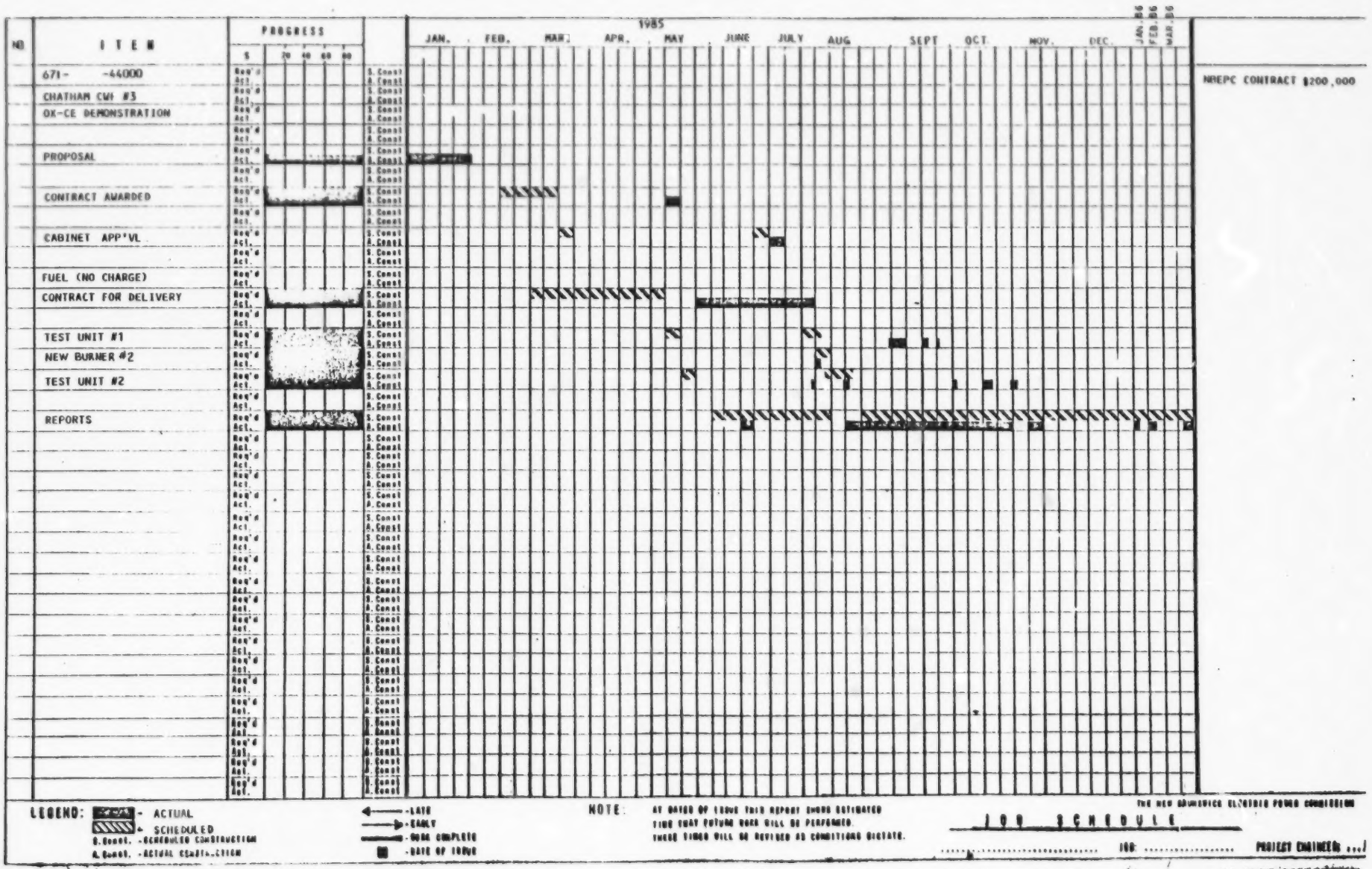
OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

APPENDIX C

PROJECT SCHEDULE


NO
ITEM
PROGRESS
1985
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV.
DEC.
671- -44000
CHATHAM CWI #3
OX-CE DEMONSTRATION
PROPOSAL
CONTRACT AWARDED
CABINET APP'VL
FUEL (NO CHARGE)
CONTRACT FOR DELIVERY
TEST UNIT #1
NEW BURNER #2
TEST UNIT #2
REPORTS
NMEPC CONTRACT $200,000
LEGEND:
ACTUAL
SCHEDULED
S.Const. -SCHEDULED CONSTRUCTION
A.Const. -ACTUAL CONSTRUCTION
-LATE
-EARLY
-WORK COMPLETE
-DATE OF ISSUE
NOTE:
JOB SCHEDULE
JOB:
PROJECT ENGINEER:

OXCE FUEL DEMONSTRATION

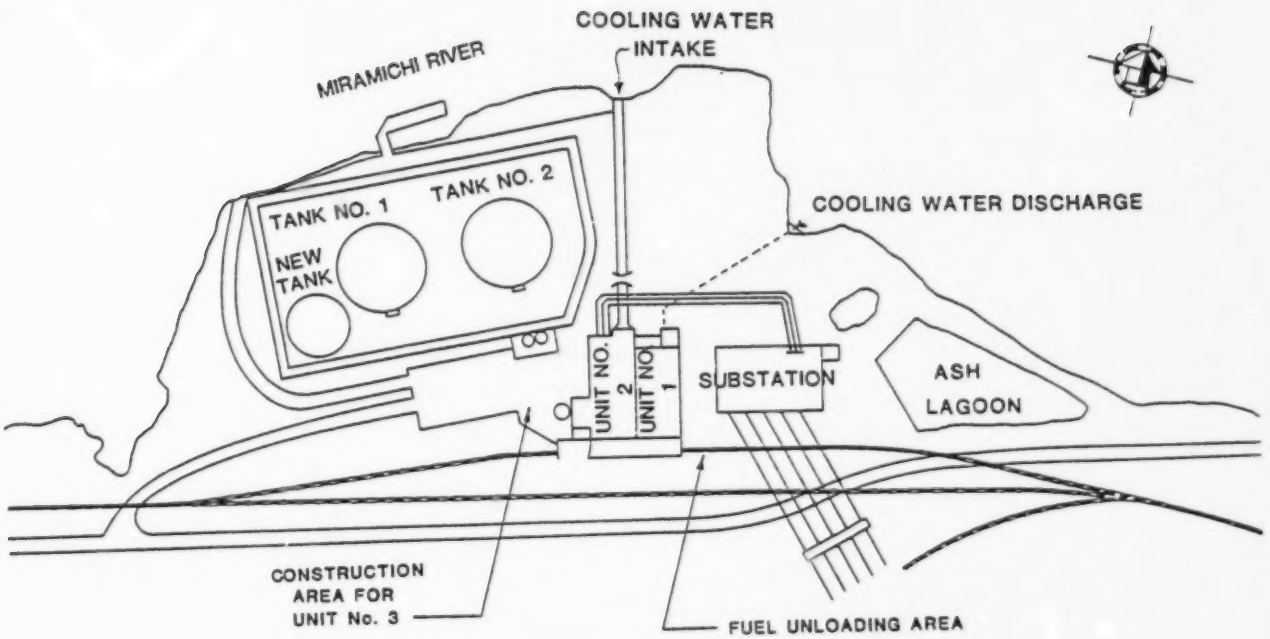
AT

N.B. POWER'S CHATHAM T.G. STATION

APPENDIX "D"

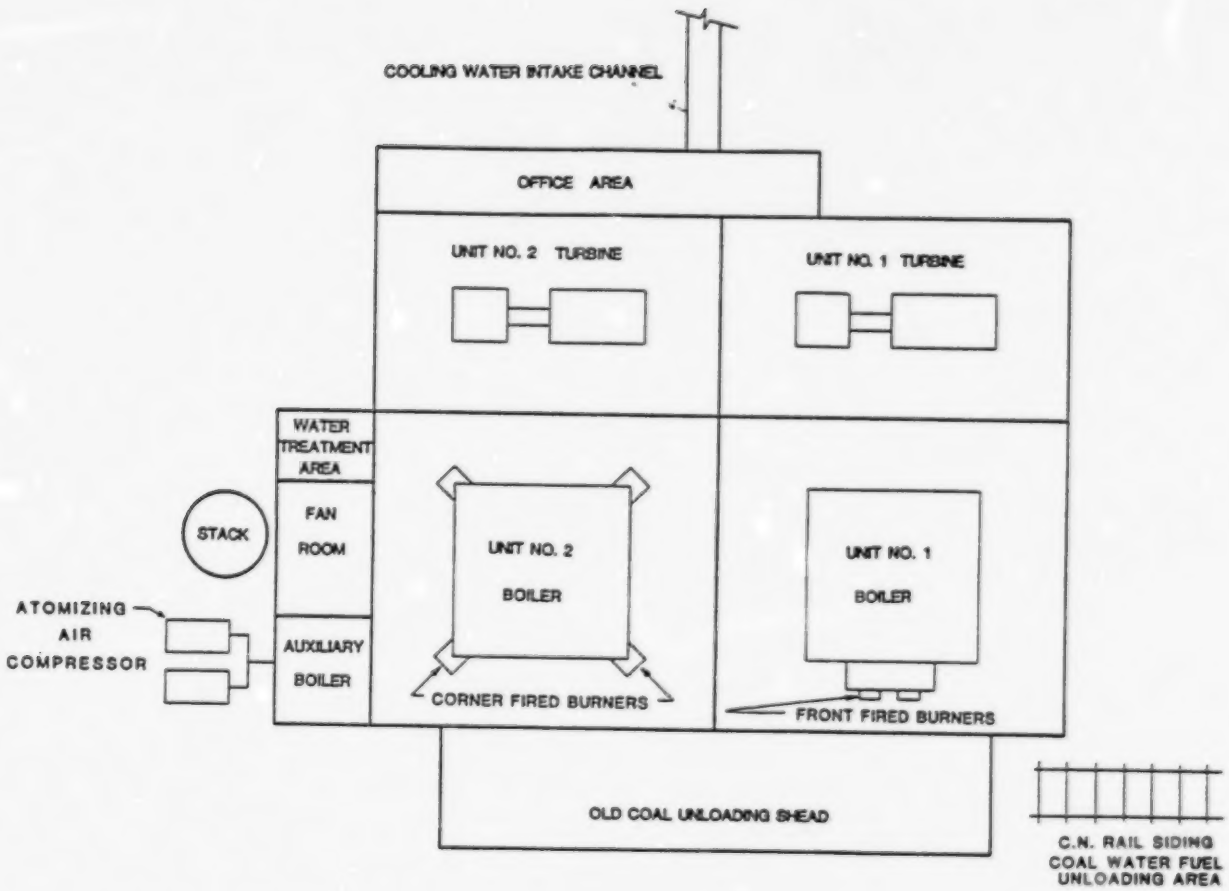
DIAGRAMS

FIGURE NO.	TITLE
D.1	Site Plan of the Chatham T.G. Station.
D.2	Floor Plan of the Chatham T.G. Station.
D.3	Isometric View of C.W.F. Piping at the Chatham T.G. Station.
D.4	Isometric View of the Unit No.1 Boiler and location of measuring points.
D.5	Part Cross-Section of the Original, Unit No.1, CWF Burner Atomizer.
D.6	Isometric View of the Unit No.2 Boiler and location of measuring points.
D.7	Cross-Section of the original Unit No.2, CWF Burner Atomizer.
D.8	History of Burner Arrangements used for the C.W.F. programs in (5-Sketches).



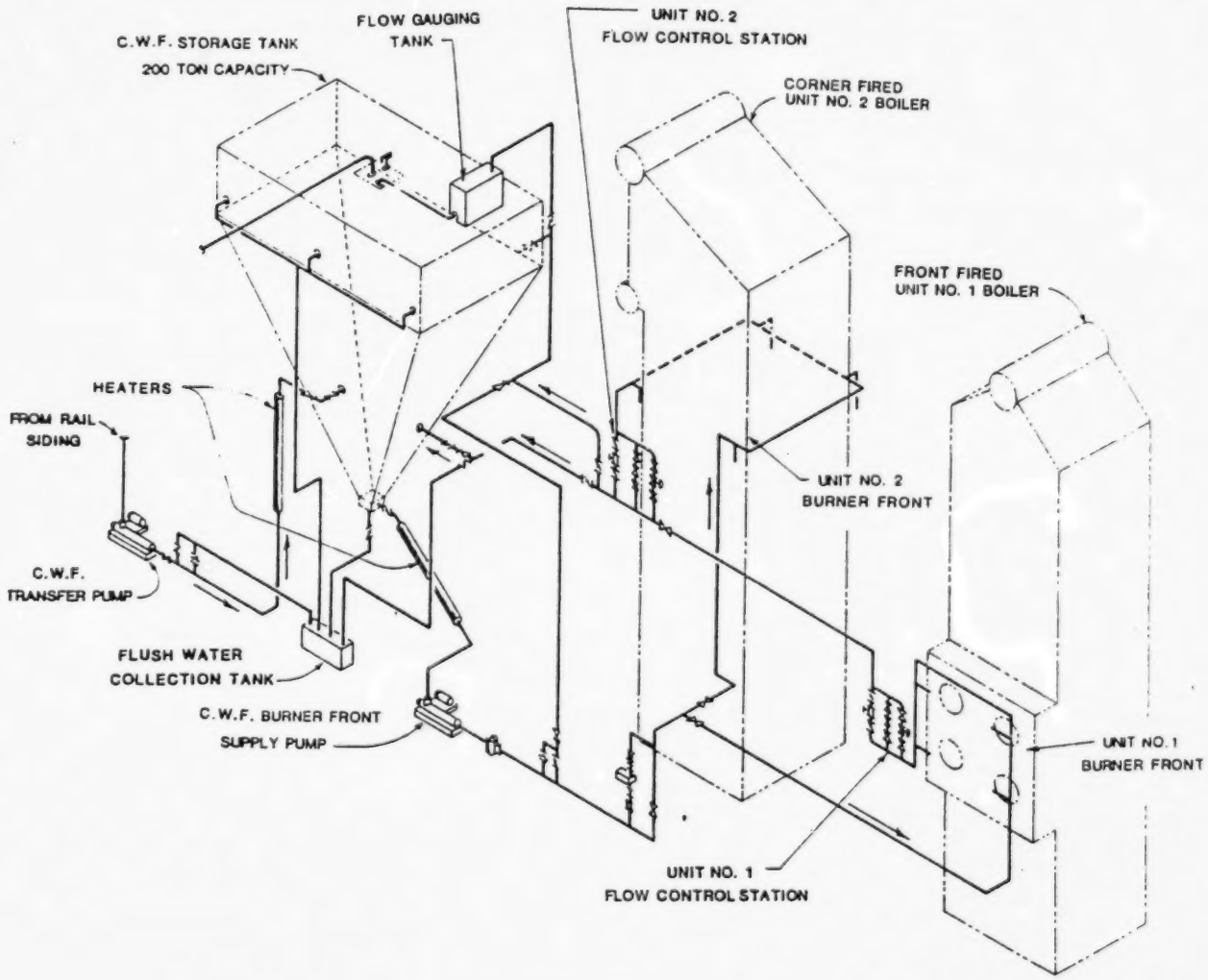
SITE PLAN
OF THE
CHATHAM T.G. STATION

FIG. D.1



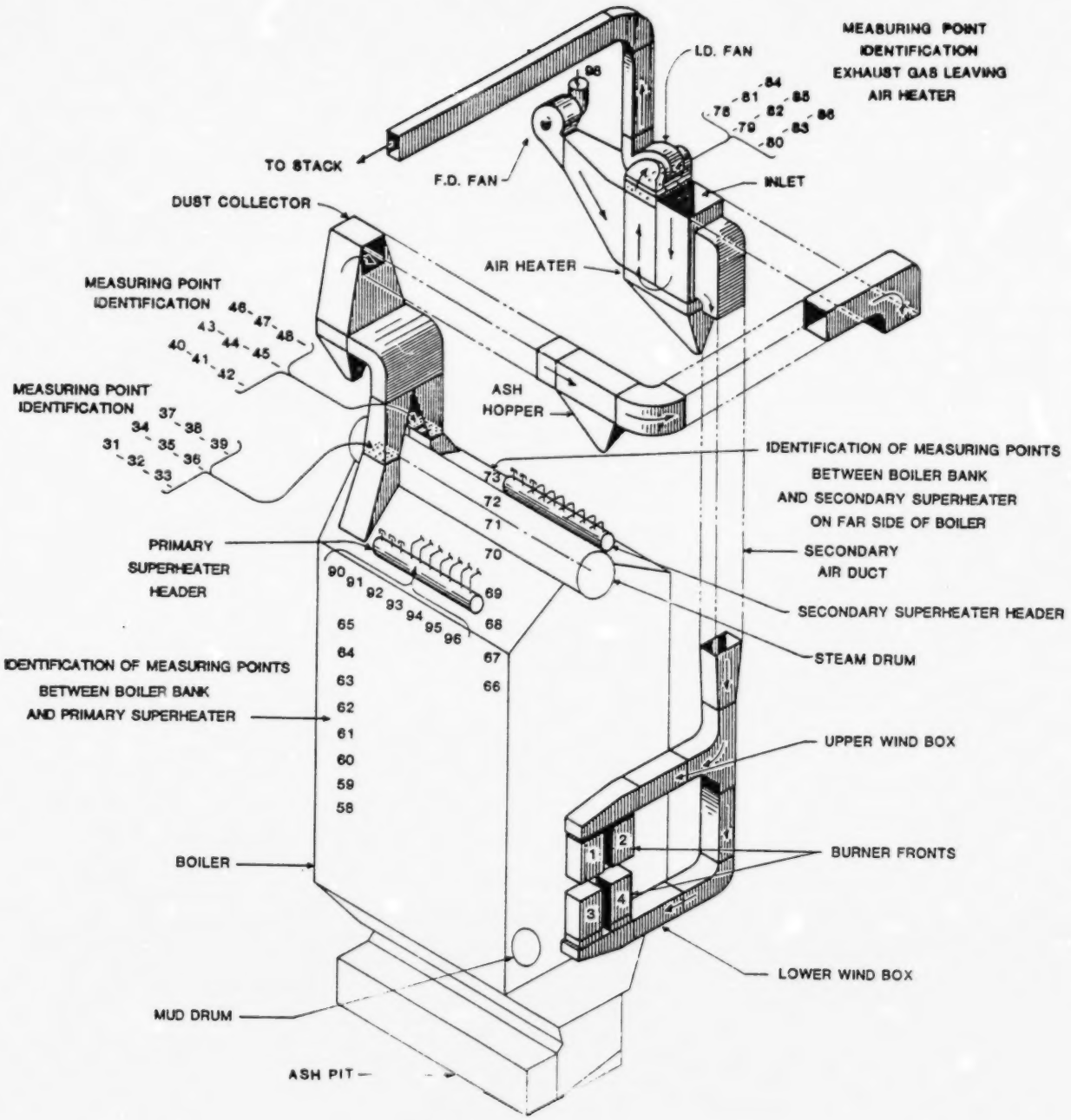
FLOOR PLAN
OF THE
CHATHAM T.G. STATION

FIG. D.2



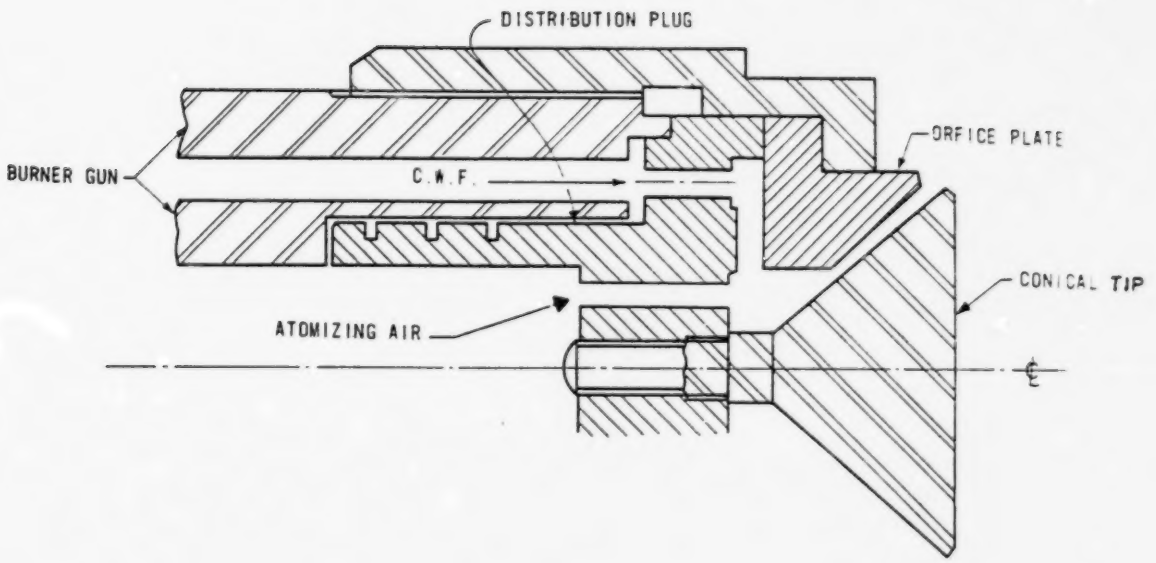
ISOMETRIC VIEW OF C.W.F. PIPING
AT THE
CHATHAM T.G. STATION

FIG. D.3



ISOMETRIC VIEW OF THE UNIT No. 1 BOILER
AND
LOCATION OF MEASURING POINTS

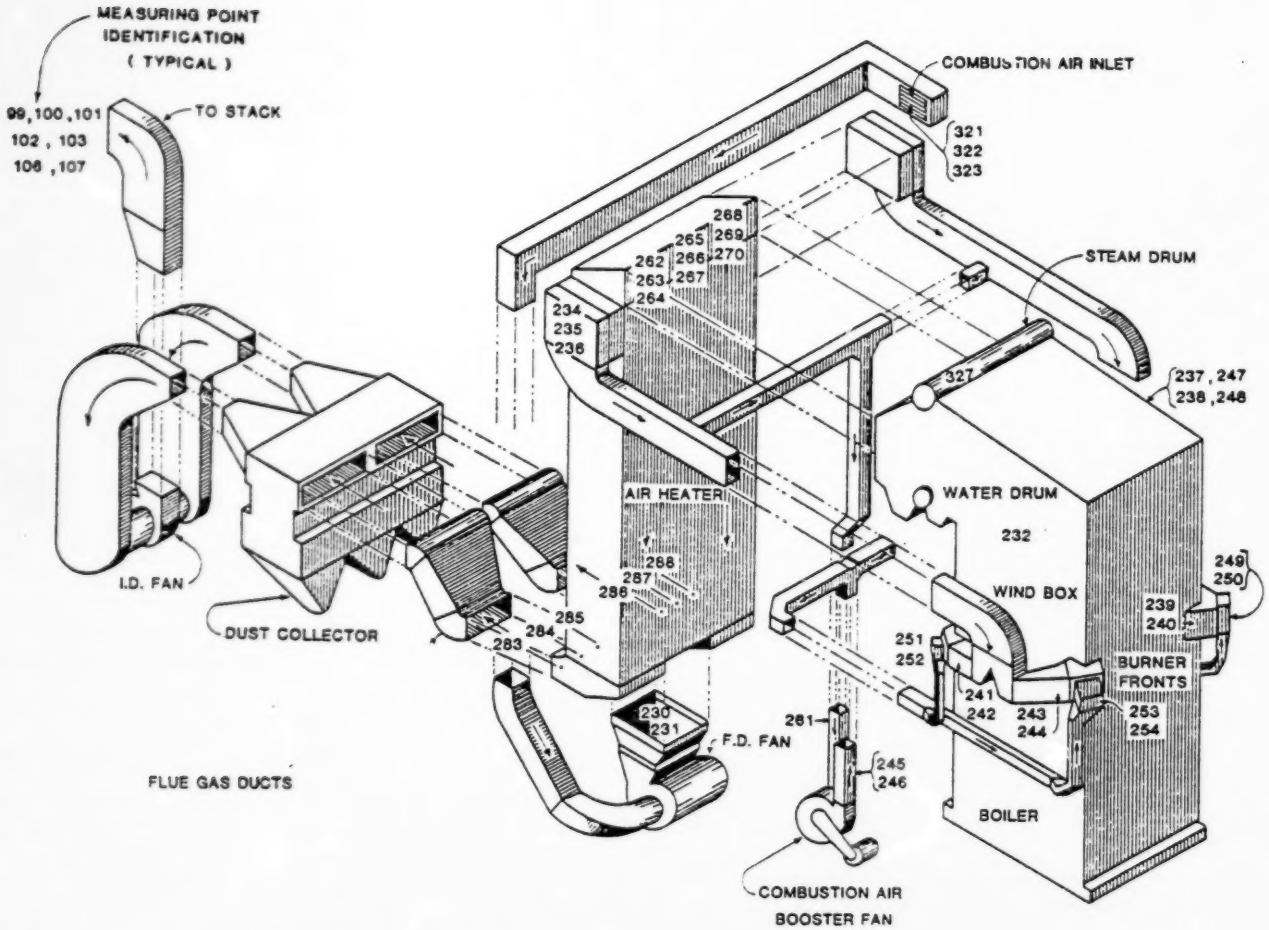
FIG. D.4



PART CROSS-SECTION
OF THE
ORIGINAL UNIT No.1 - CWF BURNER ATOMIZER

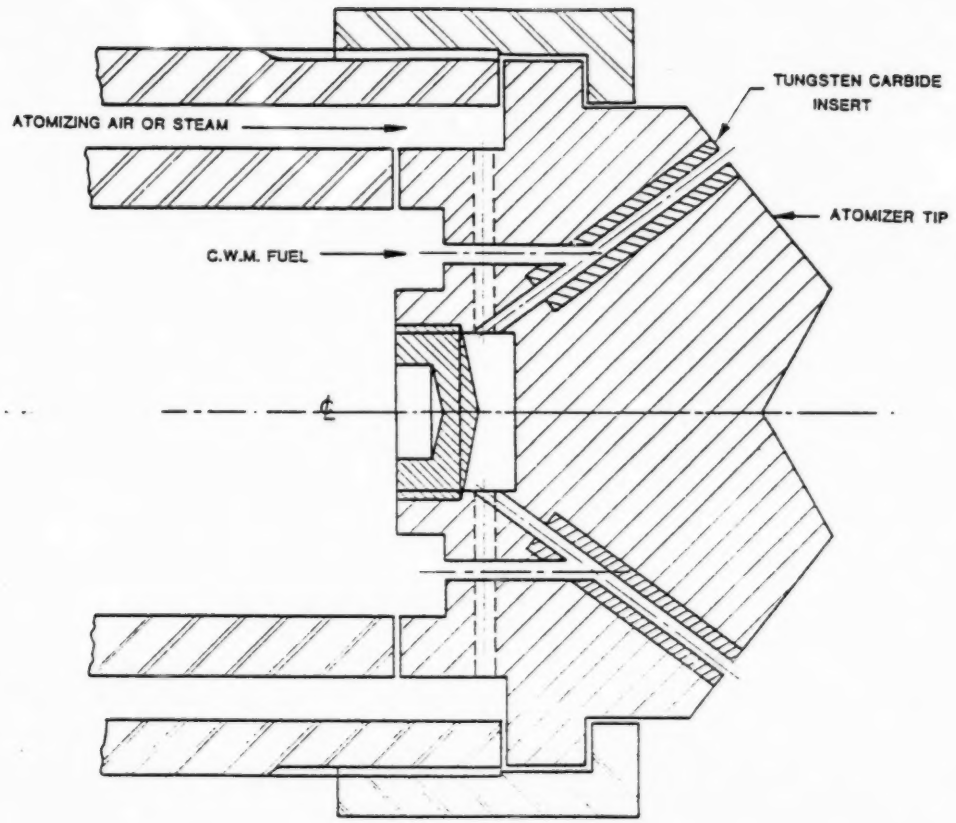
Scale - NTS

FIG. D.5



ISOMETRIC VIEW OF THE UNIT No.2 BOILER
AND
LOCATION OF MEASURING POINTS

FIG. D.6



CROSS-SECTION OF
THE
ORIGINAL UNIT No.2 CWF BURNER ATOMIZER

FIG. D.7

APPENDIX "D"

FIG. D.8

HISTORY OF BURNER ARRANGEMENTS
USED FOR THE C.W.F.
PROGRAMS IN BOILER No. 2
AT THE CHATHAM T.G. STATION

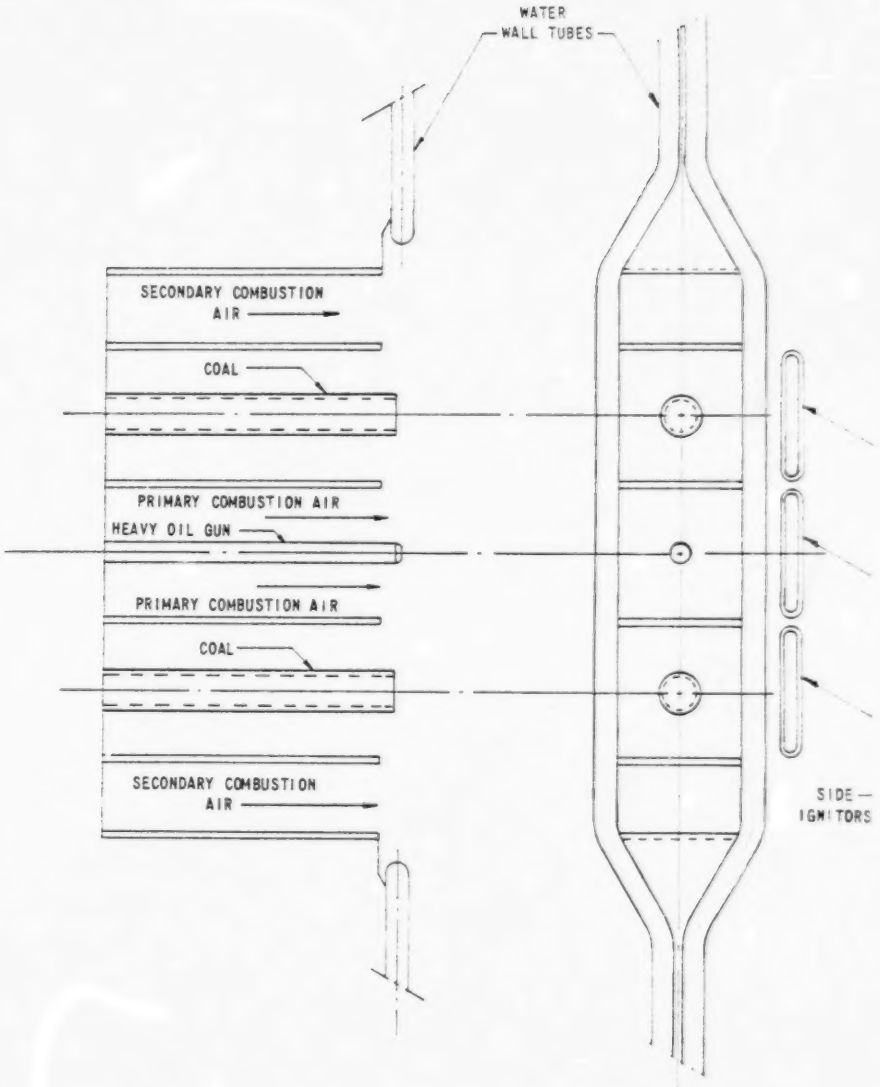
Sketch No. 1 - *ORIGINAL BURNER ARRANGEMENT FOR FIRING EITHER COAL OR OIL*

Sketch No. 2 - *1st BURNER ARRANGEMENT September 1983*

Sketch No. 3 - *2nd BURNER ARRANGEMENT November 1983*

Sketch No. 4 - *3rd BURNER ARRANGEMENT June 1984*

Sketch No. 5 - *4th BURNER ARRANGEMENT July 1985*



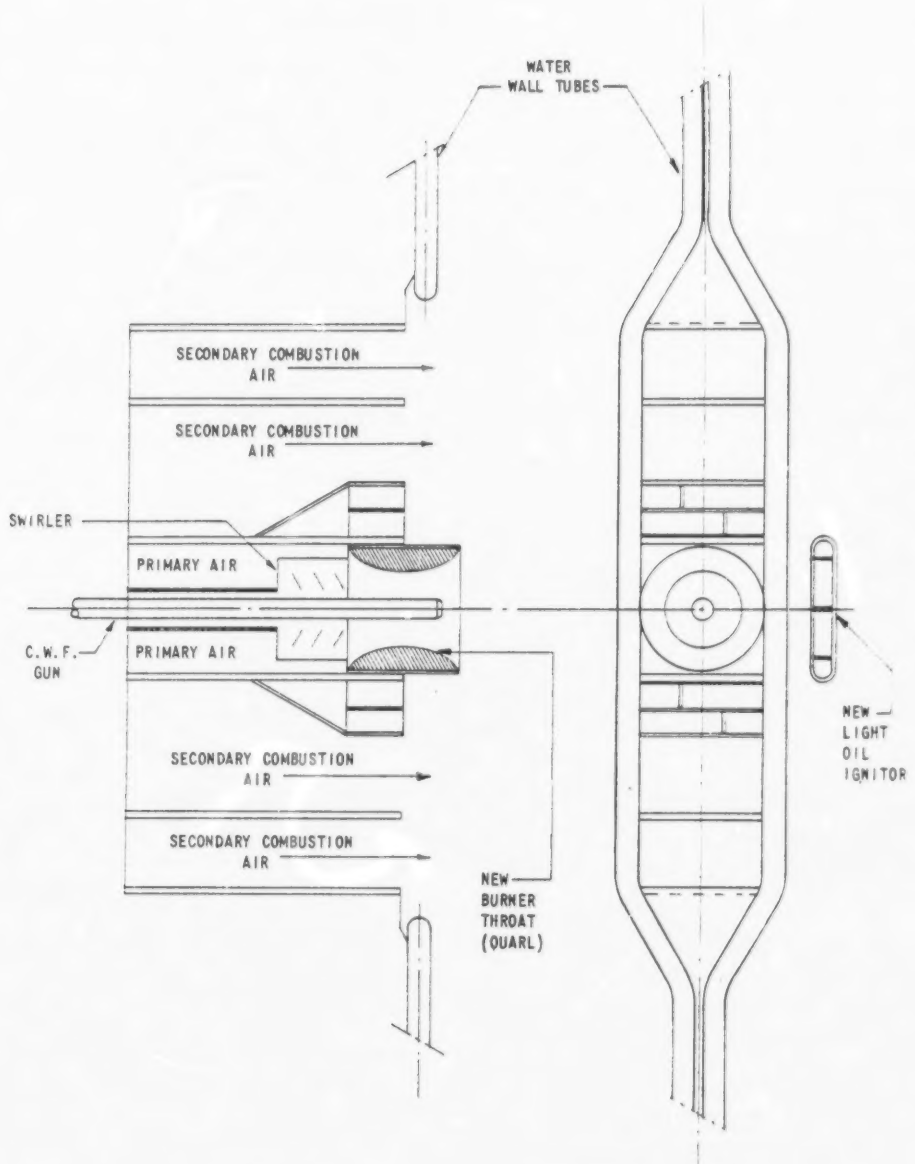
SECTION THROUGH
BURNER REGISTER

BURNER REGISTER VIEWED
FROM INSIDE OF BOILER

CHATHAM UNIT No. 2

ORIGINAL BURNER ARRANGEMENT AT
ALL FOUR CORNERS

Sketch No. 1
30 April 86



SECTION THROUGH
BURNER REGISTER

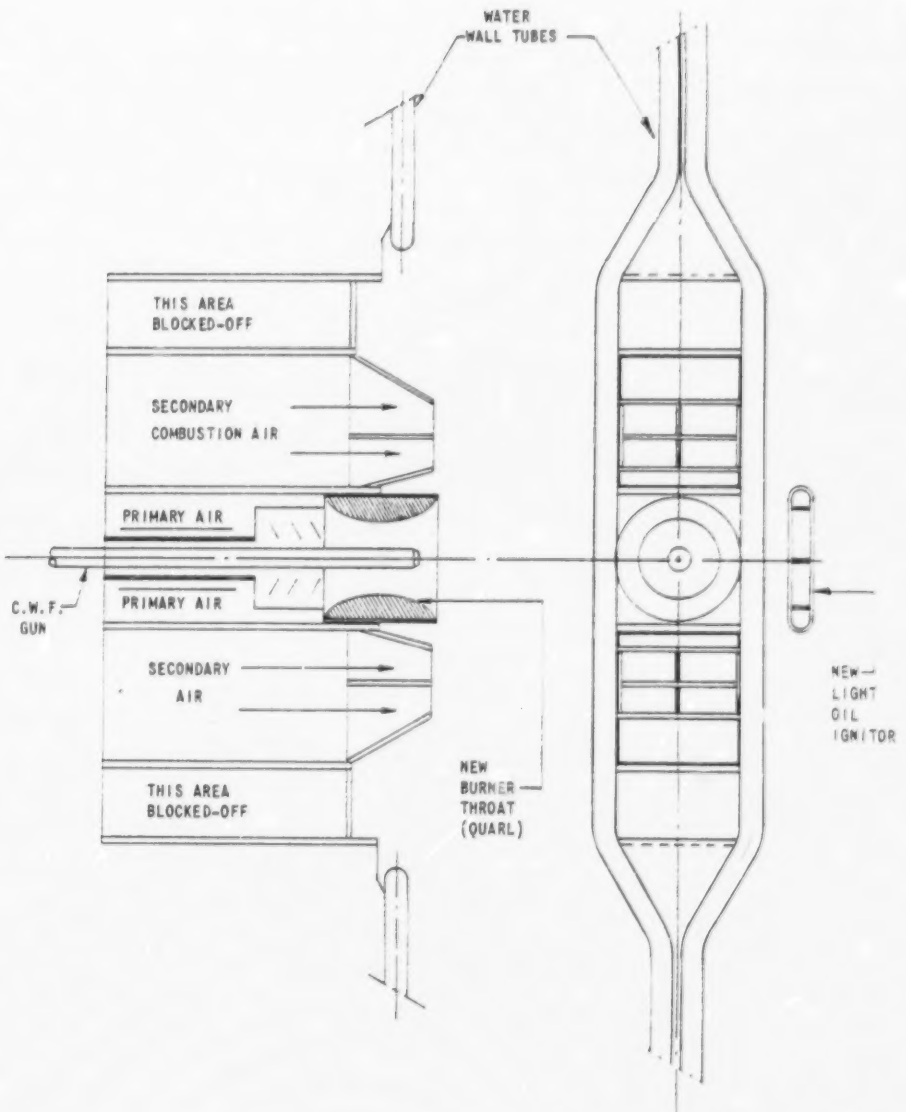
BURNER REGISTER VIEWED
FROM INSIDE OF BOILER

CHATHAM UNIT No. 2

1st BURNER ARRANGEMENT
FOR FIRING C.W.F.

September 1983

Sketch No. 2
30 April 86



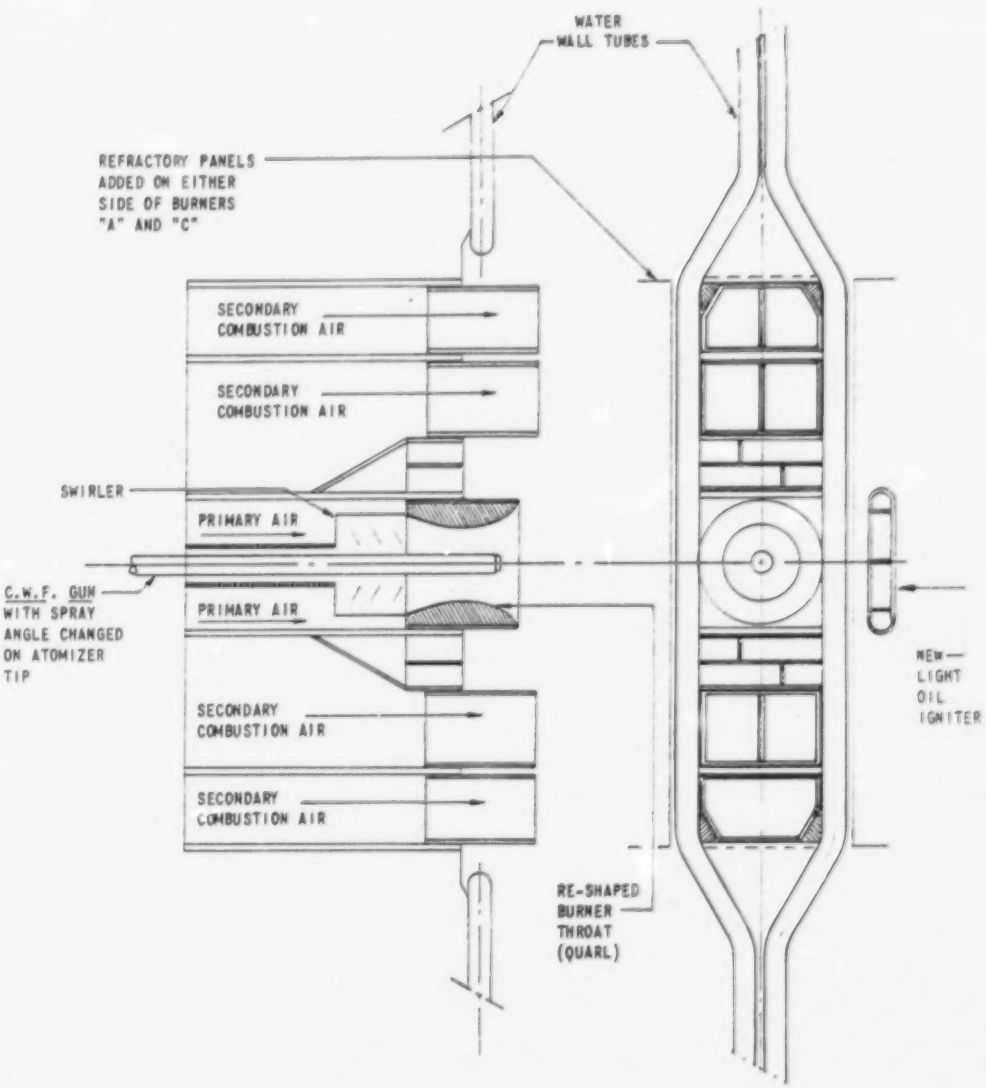
SECTION THROUGH BURNER REGISTER

BURNER REGISTER VIEWED FROM INSIDE OF BOILER

CHATHAM UNIT No. 2

2nd BURNER ARRANGEMENT
FOR FIRING C.W.F.
November 1983

Sketch No. 3
30 April 86



SECTION THROUGH BURNER REGISTER

BURNER REGISTER VIEWED FROM INSIDE OF BOILER

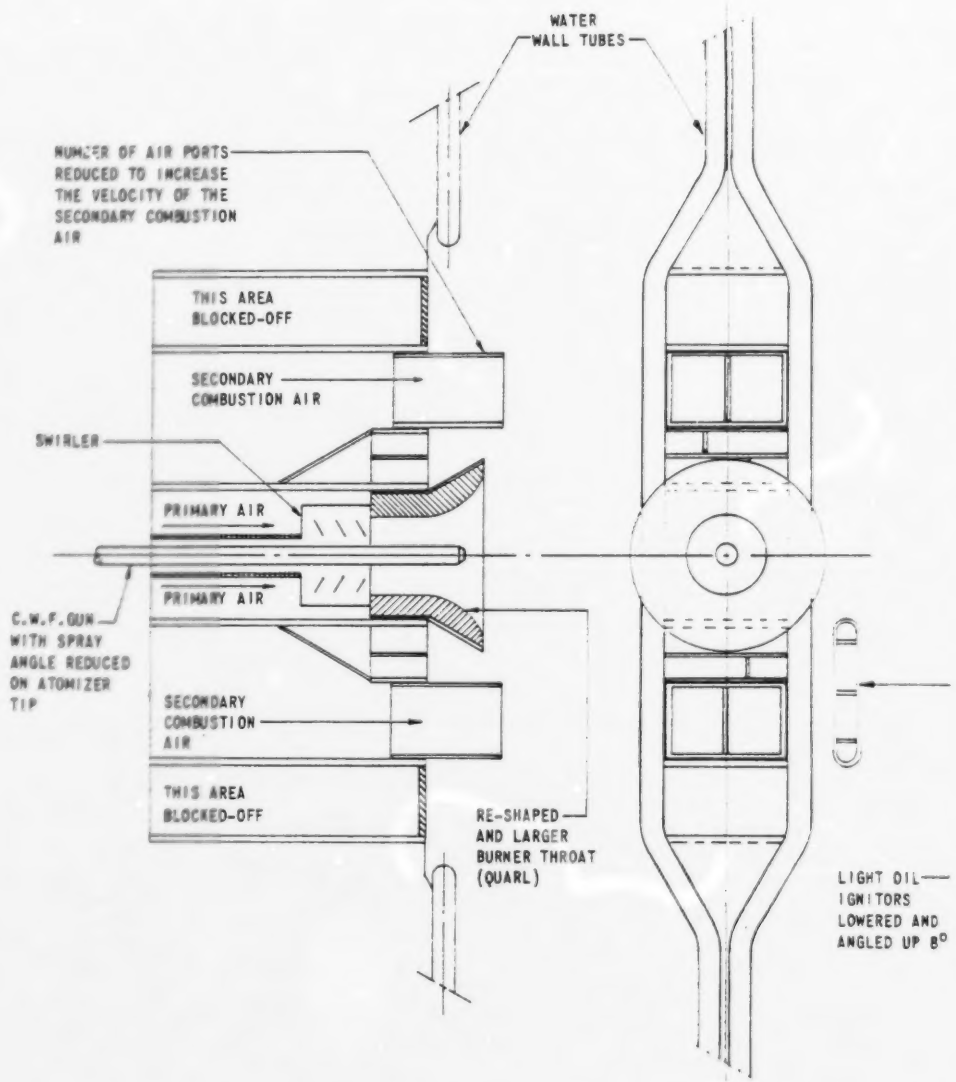
CHATHAM UNIT No. 2

3rd BURNER ARRANGEMENT

FOR FIRING C.W.F.

June 1984

Sketch No. 4
30 April 86



SECTION THROUGH BURNER REGISTER

BURNER REGISTER VIEWED FROM INSIDE OF BOILER

CHATHAM UNIT No. 2

4th BURNER ARRANGEMENT

FOR FIRING C.W.F.

July 1985

Sketch No. 5

30 April 86

OX-CE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

APPENDIX E

FUEL DATA

DATA SHEET		TITLE
E1	-	Changes in CWF.
E2	-	Changes in Viscosity of OXCE Fuel in Rail Cars.
E3	-	Summary in OX-CE fuel (June 24/85 to Sept. 20/85).
E4	-	On-site fuel inspection by the OXCE Fuel Co.
E5	-	Analysis of CWF samples taken at Burner Fronts.
E6	-	Analysis of CWF samples taken from Storage Burner.
E7	-	Analysis of OXCE Fuel used for test (Analysis by N.B. Power).
E8	-	RPC's Analysis of OX-CE CWM.
E9	-	RPC's Ash Analysis of Samples taken during the October 30, 1985 burn.

OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

DATA SHEET E.1

BACK GROUND TO CHANGES IN C.W.F.

SPECIFIC GRAVITY

The specified specific gravity for these fuels is: 1.2.

It was found during all C.W.F. Demonstration that this could vary for two reasons:

1. The amount of entrained air, very small bubbles of air that were picked up during the preparation of the coal-water fuel. This entrained air could be removed by the use of a de-foaming agent, which resulted in an increase in the specific gravity of the C.W.F.

2. The amount of moisture (water) in the fuel.

MOISTURE

- The specified moisture content for the "OXCE" fuel (CWF) is: 35% maximum.

- The general level for moisture in coal-water fuel is normally given as: 30%.

- It has been found on all the CWF programs at the Chatham Plant that these fuels burn better when the moisture content was within the range of 30 to 32%.

- The moisture content could be varied in two ways:

    1. If the moisture content was too low it could be corrected by the gradual addition of water while the fuel was being recirculated.

    2. If the moisture content was too high it could only be lowered by blending the high moisture fuel with a fuel that has a lower moisture content. If no fuel was available for blending, support ignition was required when burning the fuel with a high moisture content.

VISCOSITY

- The specified viscosity for the "OXCE" is 2,500 CP and 78°F and 100 sec. -1, maximum.

- It has been found on all the CWF programs at the Chatham Plant that these fuels atomized better when the viscosity was kept within the 600 to 700 CPS and 60 sec. -1 range, when measured with a Brookfield Viscosity Meter.

- The viscosity tends to decrease for a time after it has been prepared.

- The reason for this is the additives which were added during the fuel preparation are better dispersed with time throughout the CWF.

- As this is a slurry (a non-newtonian fluid) the velocity is not directly related to temperature but will change as work is done on it, ie., mixing (shearing of the fuel) will reduce the viscosity.

- If the viscosity is too high it can be reduced by mixing within the storage tank, or re-circulating through the fuel handling system.

- It has been found very little can be done (other than blending) if the viscosity was too low. More fuel stabilizer could have been added but this would have had an adverse effect on the atomization of the fuel.

TEMPERATURE

- As this fuel is a water based slurry, temperature should have no direct effect on the viscosity of the fuel but, due to the small amount of chemicals (fuel additives) that are added during the fuel preparation it has been found the fuel atomizes better if the fuel is supplied to the burners in the 75°F (24°C) to 85°F (30°C) range.

- Some of the coal water fuels become unstable if they are stored at temperatures over 90°F (32°).

- The fuel additives have very little effect on the freezing temperature of the water in the fuel, therefore the C.W.F. freezes at 32°F (0°C).

OXCE FUEL DEMONSTRAITON

AT

N.B. POWER'S CHATHAM T.G. STATION

DATA SHEET E. 2

CHANGES IN VISCOSITY OF OXCE FUEL IN RAIL CARS

Date	CAR NO. OR SAMPLE	VISCOSITY	DENSITY	MOISTURE	REMARKS
July 16	015018	1317@ 27°C	1.21	30.13	
"	015019	1350@ 27°C	1.21	30.06	
"	015017	1340@ 27°C	1.21	30.00	
"	094645	1293@ 27°C	1.21	30.23	
"	094648	1287@ 27°C	1.21	30.03	
"	098051	1377@ 27°C	1.17	30.05	
Aug 8	015018	843 @ 29°C	1.21	30.12	Tanks temperatures. 25°C- 26°C - 27°C
"	015019	1223 @ 29°C	1.20	30.00	
"	015017	927 @ 29°C	1.21	30.44	
"	094645	440 @ 29°C	1.21	29.68	- Starting to settle.
	094648	867 @ 30°C	1.20	30.22	
"	098051	740 @ 28°C	1.21	30.73	- Settled quite a bit.
Aug 20	015018	660 @ 23°C	1.20	30.70	In tank car @ 24°C
"	015019	507 @ 23°C	1.21	29.82	
"	015017	637 @ 23°C	1.20	30.60	
"	094645	657 @ 23°C	1.20	31.73	
"	094648	607 @ 23°C	1.20	30.13	
"	098051	727 @ 23°C	1.20	31.05	Unloaded on Aug 28.
Sept 3	015018	460 @ 23°C	1.19	33.94	Water frm top on sample.
"	015019	790 @ 23°C	1.19	30.72	6" on top - Has the less water.
"	015017	530 @ 23°C	1.19	32.30	
"	094645	NO SAMPLES	TOO MUCH WATER ON TOP TO GET		
"	094648	COLLECTED	INDICATIVES SAMPLES.		
Sept 11	094645	660 cps @ 21°C	1.20	31.32	Air lanced tank car for 8 hours.
Sept 12	094645	683 @ 20°C	1.19	30.69	Unloading line.
Oct. 25	15019	440 @ 16°C	1.19	34.55	After 3 hours of air lancing.
Oct 28	15019	550 @ 18°C	1.19	33.10	12:50 hrs air lancing tank car
Oct 29	15019	560 @ 15°C	1.19	32.28	Air lanced for 1 hour & unloaded.

OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

DATA SHEET E.3

SUMMARY OF CHANGES IN VISCOSITY OF

OXCE FUEL IN RAIL CARS

CHANGES IN OX-CE FUEL (JUNE 24/85 TO SEPT 20/85)

Rail Car No.		June 24/85	July 16/85	Aug. 8/85	Aug. 20/85	Sept. 3/85	Sept 11/85	Rmks
94648	SP. GR. % M VISC. TEMP.	1.91 30.47 1545* N/A	1.21 30.03 1287 27	1.20 30.22 867 29	1.20 30.13 607 23	Settling of Fuel Resulted in Too Much Water Near Surface to Take Samples	Settled Fuel	------ ------
94645	SP. GR. % M VISC. TEMP.	1.199 30.41 1771* N/A	1.21 30.23 1293 27	1.21 29.68 440 29	1.20 31.73 657 23		1.19 30.64 683 20	After Remixing/ Agitating.
98051	SP. GR. % M VISC. TEMP.	1.194 30.38 1771* N/A	1.17 30.05 1377 27	1.21 30.73 740 28	1.20 31.05 727 23		Settled Fuel	------ ------
15017	SP. GR. % M VISC. TEMP.	1.189 30.48 1719* N/A	1.21 30.0 1340 27	1.21 30.44 927 29	1.20 30.60 637 23	1.19 32.30 530 23	Settled Fuel	------ ------
15018	SP. GR. % M VISC. TEMP.	1.181 30.48 1687* N/A	1.21 30.13 1317 27	1.21 30.21 843 29	1.20 30.70 660 23	1.19 33.94 460 23	Settled Fuel	------ ------
15019	SP. GR. % M VISC. TEMP.	1.189 30.37 1847* N/A	1.21 30.06 1350 27	1.20 30.0 1223 29	1.21 29.82 507 23	1.19 30.72 790 23	1.19 32.28 560 15	After Remixing/ Agitating.

*VISCOSITY MEASURED @ 75 SEC -1 ON HAAKE VISCOSITY METER
ALL REMAINING VISCOSITIES WERE MEASURED @ 60 SEC -1 ON A BROOKFIELD VISCOSITY METER.

OXCE FUEL DEMONSTRATION
AT
N.B. POWER'S CHATHAM T.G. STATION

DATA SHEET E.4

ON-SITE FUEL INSPECTION BY THE OXCE FUEL CO.

OCTOBER 9, 1985

RAIL CAR INSPECTION - GREG DUBIN - OXCE FUEL CO

THREE CARS (GATX TANK TRAINS)
OFF SITE - 2 MILES.

CAR NO. 15017
6-8" Water on top.
2-3" Soft Pack
6' Max. Penetration Depth

Car No. 15018
8-12" Water
3-5" Soft Pack
5'10" Max. Penetration

Car No. 15019
8-10" Water
5" Soft Pack
5'6" Max penetration

OXCE COAL WATER FUEL
TANK CAR INSPECTION 8-22-85

Car No. 98051
3-4" Water
12-15" Soft Pack
67" Depth
Unloaded on Aug 29

Car No. 94648
2" Water
5" Settling
70" Depth

Car No. 94645
1-2" Water on top
2" Soft Pack
69" from Hard (Bottom?) to Slurry Surface

Car No. 15017
2" Water
2" Soft Pack
77" Depth

Car No. 15018
3-4" Water
1" Soft Pack
76" Depth

Car No. 15019
1-2" Water
1-2" Settling
76" Depth

OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

DATA SHEET E.5

ANALYSIS OF CWF SAMPLES TAKEN AT BURNER FRONTS

DATE	CAR NO. OR SAMPLE	VISCOSITY	DENSITY	MOISTURE	REMARKS
Aug 30	Burner Front	417 @ 29°C	1.19	32.61%	
Sept 5	" "	400 @ 21°C	1.19	33.48%	Starting to Settle.
6	" "	420 @ 24°C	1.20	33.66	
		TANK CAR BURNED OUT 2 OTHERS UNLOADED IN BUNKER			
Sept 13	" "	590 @ 20°C	1.20	31.59	09645
16	" "	620 @ 19°C	1.20	31.26	Unloaded T.C.#094648
17	" "	610 @ 25°C	1.20	31.12	
18	" "	560 @ 24°C	1.20	31.48	
19	" "	560 @ 24°C	1.20	31.77	
26	" "	610 @ 25°C	1.15	32.02	Around #2 BLR Burners
30	" "	610 @ 26°C	1.14	33.17	
Oct 1st	" "	625 @ 25°C	1.15	32.68	Around #1 BLR Burners
3rd	" "	605 @ 22°C	1.15	32.01	" " "
7th	" "	810 @ 28°C	1.20	32.17	Around #2 Burners
8th	" "	760 @ 23°C	1.18	31.40	
9th	" "	760 @ 22°C	1.19	31.96	Can't burn fuel as it started to gell with the heat factor.
10th	" "	760 @ 25°C	1.20	31.24	OXCE Fuel Representative will be here next week to retreat fuel.
11th	" "	710 @ 22°C	1.20	32.26	
15th	" "	820 @ 20°C	1.18	31.48	
16th	" "	325 @ 24°C	1.16	31.68	Treated the fuel
17th	" "	325 @ 22°C	1.19	31.66	
18th	" "	325 @ 22°C	1.19	30.86%	Fuel burned out.
		TANK CAR 15019 UNLOADED & TREATED			
30th	" "	400 @ 21°C	1.19	31.89	
31st	" "	380 @ 22°C	1.19	32.56	
Nov 1st	" "	360 @ 24°C	1.18	32.38	10:30 hrs

Notes: Burner/Fuel Test conducted on Oct. 31/85.

All OXCE fuel in Bunker Burnt by Nov. 1/85.

OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

DATA SHEET E.6

ANALYSIS OF CWF SAMPLES TAKE FROM STORAGE BUNKER

DATE	CAR NO. OR SAMPLE	VISCOSITY	DENSITY	MOISTURE	REMARKS
Aug 29/85	BUNKER	500 cps @ 25°C	1.19	33.24	(12 inches off Top the top)
	"	500 @ 25°C	1.19	33.26	BOTTOM
UN-LOADED	TANK CAR 98051 - 67 TONS IN BUNKER - ABOUT 1½ FEET OF SETTLED FUEL				
	IS STILL IN TANK CAR.				
AUG 30th	BUNKER	493 @ 23°C	1.19	32.70	TOP
	"	487 @ 23°C	1.19	32.64	BOTTOM
Sept 3rd	"	400 @ 21°C	1.20	34.04	TOP ½ of bunker burned out
	"	490 @ 21°C	1.20	32.86	BOTTOM
4th	"	530 @ 20°C	1.20	31.98	TOP
	"	610 @ 20°C	1.20	31.17	BOTTOM
5th	"	500 @ 21°C	1.19	33.04	TOP
	"	660 @ 20°C	1.20	31.15	BOTTOM
Sept 6th	"	420 @ 24°C	1.20	33.66	TOP bunker
	"	410 @ 22°C	1.20	34.00	BOTTOM completely burned out
WATER ADDED TO BUNKER RECIRCULATED IN SYSTEM, AND THEN DRAIN TO ASH LAGOON					
Sept 13	BUNKER	610 @ 20°C	1.20	31.45	TOP unloaded T.C. #094645
	"	590 @ 18°C	1.20	30.99	BOTTOM
Sept 15	BUNKER	620 @ 20°C	1.20	32.24	TOP Fuel on Recirc.
	"	660 @ 20°C	1.20	31.46	BOTTOM "
16	"	610 @ 20°C	1.20	31.11	TOP "
	"	610 @ 20°C	1.20	31.16	BOTTOM #094648 being unloaded tonight
17	"	560 @ 25°C	1.20	31.42	TOP
	"	680 @ 25°C	1.20	31.07	BOTTOM
18	"	540 @ 23°C	1.20	31.61	TOP
	"	560 @ 21°C	1.20	31.34	BOTTOM

OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

DATA SHEET E.6

ANALYSIS OF CWF SAMPLES TAKEN FROM STORAGE BUNKER

DATE	CAR NO. OR SAMPLE	VISCOSITY	DENSITY	MOISTURE	REMARKS
Sept 19	BUNKER	410 @ 23°C	1.19	34.00	Top
	"	670 @ 23°C	1.20	31.22	BOTTOM
20	"	350 @ 25°C	1.19	34.03	TOP
	"	610 @ 25°C	1.20	31.26	BOTTOM
23	"	615 @ 23°C	1.15	31.68	TOP
	"	795 @ 23°C	1.20	30.42	BOTTOM
24	"	635 @ 22°C	1.15	31.66	TOP
	"	760 @ 22°C	1.20	30.93	BOTTOM
25	"	610 @ 22°C	1.17	31.94	TOP
	"	780 @ 22°C	1.20	31.18	BOTTOM
26	"	635 @ 24°C	1.15	31.29	TOP
	"	665 @ 24°C	1.15	31.37	BOTTOM
27	BUNKER	660 @ 25°C	1.20	31.02	BOTTOM RECIRC
30	"	600 @ 26°C	1.14	32.65	TOP
	"	770 @ 25°C	1.21	30.30	BOTTOM
Oct 1	"	610 @ 25°C	1.15	32.18	TOP
	"	660 @ 25°C	1.18	31.28	BOTTOM
3	"	600 @ 23°C	1.15	32.11	TOP
	"	660 @ 23°C	1.18	31.54	BOTTOM
4	"	600 @ 22°C	1.15	32.14	TOP
	"	650 @ 21°C	1.18	31.59	BOTTOM
7	"	1050 @ 26°C	1.18	28.69	TOP
	"	680 @ 25°C	1.14	31.26	BOTTOM
8	"	960 @ 23°C	1.20	30.15	TOP *fuel is getting
9	"	840 @ 22°C	1.15	31.60	TOP thick pudding

OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

DATA SHEET E.6

ANALYSIS OF CWF SAMPLES TAKEN FROM STORAGE BUNKER

DATE	CAR NO. OR SAMPLE	VISCOSITY	DENSITY	MOISTURE	REMARKS
Oct 10	BUNKER	820 @ 25°C	1.18	29.75	TOP consistency. Not burning
11	"	760 @ 22°C	1.14	31.33	TOP because it plugs the guns.
	"	860 @ 21°C	1.18	31.14	BOTTOM
15	"	660 @ 20°C	1.14	32.60	TOP
	"	860 @ 20°C	1.20	30.36	BOTTOM
	"	860 @ 22°C	1.18	31.70%	
REPRESENTATIVES FROM OXCEFUEL CAME TO PLANT TO RE-TREAT FUEL IN BUNKER.					
Oct 16 -	ADDED 0.1% OF	DISPERSENT IN	A FLAKE FORM	ADDED TO	RECIRCULATION FLOW
	BUNKER	960 @ 22°C	1.21	29.97	BOTTOM (MANUALY) 12:50
	"	550 @ 22°C	1.19	31.56	B.F. "
	"	700 @ 23°C	1.20	30.20	BOTTOM 15:15
	"	325 @ 24°C	1.16	31.68	B.F. "
Oct 17	"	310 @ 24°C	1.19	31.80	BOTTOM Fuel mixed evenly, try
	"	325 @ 22°C	1.19	31.66	B.F. to burn bunker out today
18	"	320 @ 24°C	1.19	30.86*	BOTTOM approx 30 tons left
	"	310 @ 24°C	1.19	30.98*	B.F. *moisture is slower
Oct 29	T.C.15019 UNLOADED IN BUNKER. 80 LBS OF DISPERSENT ADDED IN RECIRC				
30	OVERFLOW (.05% IN WEIGHT) BUNKER	450 @ 21°C	1.19	31.89	T.C. 15019 TOP 72.6 Tons
	"	750 @ 16°C	1.20	31.73	BOTTOM
Nov 1	"	360 @ 24°C	1.18	32.38	10:30 hrs.
	BUNKER BURNED OUT @ 14:30 HRS.				

OXCE FUEL DEMONSTRATION

AT

N.B. POWERS CHATHAM T.G. STATION

DATA SHEET E.7

ANALYSIS OF OXCE FUEL USED FOR TEST

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION

COMPLETE ANALYSIS FOR COAL WATER MIXTURE

OXCE FUEL

DATE (OF ANALYSIS)		85-11-20				
TIME						
SAMPLE #		Burner Front from test with Combustion Engineering				
					FUEL ANALYSIS	
VISCOSITY	cps	360 @ 24°C				
TEMPERATURE	C	24°C				
SPECIFIC GRAVITY		1.16				
MOISTURE	%	32.87				
ASH DRY BASIS	%	5.31				
VOLATILE MATTER	%	23.94				
FIXED CARBON	%	37.88				
GROSS CAL. VAL.	BTU/LB	9640.75				
SULPHUR	%	0.99				
					FLY ASH	
MOISTURE	%	0				
UNBURNT CARBON	%	40.74				
					BOTTOM ASH	
MOISTURE	%	0				
UNBURNT CARBON	%	33.37				

Analyst Brenda Nixon

DATA SHEET E.8

REPORT NUMBER: IC/85/134 DATE: December 6, 1985

JOB NUMBER: 082000/044A

File: CWF.9 3.0 Chatham
Coal/Water Burner Development
OXCE TEST - FUEL
Date: 6 DEC. 85

RECEIVED - 16DEC.85

Mr. M. Thanisch
Engineering Department
N. B. E. P C.
515 King Street
Fredericton, N. B.

Analysis of "Oxcefuel", Chatham Project

I.C. Code 85/364

On Nov. 14, 1985 a can labelled "#2 Burner Front 85-11-01 OXCEFUEL C.W.M." was received at RPC for analyses as specified by the client.

Results:

A) "OXCEFUEL C.W.M."

	As Received	100% Dry (detn)
Moisture (%)	32.55 (detn)	--
Ash (%)	3.68 (calc)	5.45
Calorific Value (BTU/lb)	9372 (calc)	13895
Sulphur (%)	0.53 (calc)	0.79
Carbon (%)	53.72 (calc)*	79.65
Hydrogen (%)	3.39 (calc)*	5.02
Nitrogen (%)	1.02 (calc)	1.51
Oxygen (by difference) (%)	5.11 (calc)*	7.58

Notes: detn = determined value
calc = value calculated from results of analysis on dry material
* = these values do NOT take into account the hydrogen and oxygen present in the water of the "as received" fuel.

D. R. Kirby
Section Head,
Analytical Services and
Industrial Chemistry

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DATA SHEET E.9

REPORT NUMBER: IC/85/167 DATE: February 28, 1986

JOB NUMBER: 082000/044A Part 2

File: CWF.3. Chatham
Coal/Water Burner Development
OXCE FOR TEST
Date: 28 FEB 86

Mr. M. Thanisch
Engineering Dept.
NBEPC
515 King Street
Fredericton, New Brunswick

Analysis of Fly Ash and Bottom Ash
Chatham CWF Project

On November 22, 1985, D. R. Kirby collected two containers labelled: "Fly Ash Nov. 1st, 1985" and "Bottom Ash Nov. 1st/85" from NBEPC for specified analyses.

Results: (as received basis)

I. C. Code	85/375	85/375
Label	Fly Ash	Bottom Ash
Moisture (%)	0.55	0.80
Volatile Matter (%)	3.05	9.4
Loss on Ignition @ 1050°C (%)	59.75	75.0

Derek Kirby
Section Head,
Analytical Services and
Industrial Chemistry

/mb

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OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

APPENDIX F

CHEMICAL LABORATORY PROCEDURES

SECTION	TITLE
F.1	Moisture in the Analysis Sample of Coal. (3.04.1).
F.2	Ash in the Analysis Sample of Coal. (3.01.1).
F.3	Volatile Matter in Analysis Sample of Coal. (3.06.1).
F.4	Fixed Carbon in Analysis Sample of Coal. (3.02.1).
F.5	Gross Calorific Value of Solid Fuel by the Isothermal - Jacket Bomb Calorimeter. (3.03.1).
F.6	Total Sulphur in the Analysis Sample of Coal. (3.05.1).
F.7	Viscosity Test Procedure
F.8	Determination of % Combustible (Unburnt Carbon) in Ash.

SECTION F.1

NB POWER

CHEMICAL LABORATORY PROCEDURE

MOISTURE IN THE ANALYSIS SAMPLE OF COAL

1.0 Theoretical Background

This method covers the determination of moisture in the analysis sample of coal. It is used for calculating other analytical results to a dry basis.

2.0 Outline of Method

Moisture is determined by establishing the loss in weight of the sample when heated under rigidly controlled conditions of temperature, time and atmosphere, sample weight and equipment specifications.

3.0 Interferences

None.

4.0 Apparatus

4.1 Drying oven - should be so constructed as to have a uniform temperature in all parts, have a minimum of air space and be capable of temperature regulation between the limits of 104 and 110°C. Provision should be made for renewing the preheated air in the oven at the rate of two to four times a minute, with the air dried bypassing it through sulphuric acid. The door should contain a hole of approximately 3.2 mm in diameter near the bottom to permit a free flow of air through the oven space.

4.2 Capsules with covers, porcelain, 22 mm in depth and 44 mm in diameter, or a fused silica capsule of similar shape. This shall be used with a well-fitting flat aluminum cover. Platinum crucibles or glass capsules with ground-glass caps may also be used. They should be as shallow as possible, consistent with convenient handling.

5.0 Precautions

As a safety precaution magnesium perchlorate should not be regenerated for reuse. It should be destroyed by dissolving in water and flushing down a drain.

6.0 Reagents

Dessicant: Sulphuric Acid, spgr 1.84 or Anhydrous Magnesium Perchlorate ($Mg(ClO_4)_2$) approximately 2.36 mm (NO.8) sieve.

7.0 Procedure

7.1 The analysis sample is that sample which has been pulverized to pass 250 um (NO.60) sieve.

7.2 Heat the empty capsules under the conditions at which the sample is to be dried, place the stopper or cover on the capsule, cool over a dessicant for 15 to 30 min and weigh. Dip out with a spoon or spatula from the sample bottle approximately 1 g of the sample. Put this quickly into the capsule, close and weigh at once.

7.3 After removing the covers, quickly place the capsules in a preheated oven (at 104 to 110°C) through which passes a current of air dried by H_2SO_4. Close the oven at once and heat for 1 h. Open the oven, cover the capsules quickly, cool in a dessicator over dessicant and weigh as soon as cold.

8.0 Calculations

Moisture in analysis sample, %
$$= [(A-B)/A] \times 100$$

where A = grams of sample used
B = grams of sample after heating

9.0 Precision

Duplicate results by the same laboratory should not be considered suspect unless they differ by more than 0.2% for coals having less than 5% moisture and 0.3% for coals having more than 5% moisture.

10.0 Reference

1. A.S.T.M; D-3173

NB POWER

CHEMICAL LABORATORY PROCEDURE

ASH IN THE ANALYSIS SAMPLE OF COAL

1.0 Theoretical Background

This method covers the determination of the ash content in the analysis sample of coal.

2.0 Outline of Method

Ash is determined by weighing the residue remaining after burning the coal under rigidly controlled conditions of sample weight, temperature, time and atmosphere.

3.0 Interferences

None.

4.0 Apparatus

4.1 Gas or Electric Muffle Furnace shall have an adequate air circulation and be capable of having its temperature regulated between 700 and 750°C.

4.2 Porcelain capsules, about 22 mm in depth, and 44 mm in depth, or similar shallow dishes or platinum crucibles.

5.0 Precautions

None.

6.0 Reagents

None.

7.0 Procedure

7.1 Transfer approximately 1 g of the sample to a weighed porcelain capsule with a spoon or spatula and quickly establish the weight to the nearest 0.1 mg. An alternative way is to use the dried coal from the moisture determination

7.2 Place the porcelain capsule containing the sample in a cold muffle furnace, or on a hearth at a low temperature, and gradually heat to redness at such a rate as to avoid mechanical loss from too rapid expulsion of volatile matter.

7.3 Finish the ignition to constant weight (±0.001 g) at a temperature between 700 and 750°C.

7.4 Cool in a dessicator over dessicant and weigh as soon as cold.

8.0 Calculations

Ash in analysis sample, % = [(A-B)/C] x 100

where A = weight of capsule and ash residue, g,
B = weight of empty capsule, g,
C = weight of analysis sample used, g.

9.0 Precision

Duplicate results by the same laboratory should not be considered suspect unless they differ by more than the following percentages:

No carbonates present	0.2
Carbonates present	0.3
Coals with more than 12% ash, containing carbonates and pyrites	0.5

10.0 Reference

1. A.S.T.M; D-3174

NB POWER

CHEMICAL LABORATORY PROCEDURE

VOLATILE MATTER IN THE ANALYSIS SAMPLE OF COAL

1.0 Theoretical Background

This method determines the percentage of gaseous products, exclusive of moisture vapour, in the analysis sample which are released under the specific conditions of the test. Volatile matter, when determined as herein described, may be used to establish the rank of coals, to provide the basis for purchasing and selling, or to establish burning characteristics.

2.0 Outline of Method

Volatile matter is determined by establishing the loss in weight resulting from heating a coal under rigidly controlled conditions. The measured weight loss, corrected for moisture, establishes the matter content.

3.0 Interferences

None.

4.0 Apparatus

4.1 Platinum crucible, with closely fitting cover, should be of not less than 10 or more than 20 ml capacity, not less than 25 or more than 35 mm in diameter, and not less than 30 or more than 35 mm in height.

4.2 Vertical Electric Tube Furnace, regulated to maintain a temperature of 950 $\pm$ 20°C in the crucible, as measured by thermocouple positioned in the furnace.

5.0 Precautions

Regulation of the temperature to within the prescribed limits is critical.

6.0 Reagents

None.

7.0 Procedure

7.1 Weigh 1 g of the sample in a weighed platinum crucible, close with a cover, place on platinum or Nichrome-wire supports and insert directly into the furnace chamber, which shall be maintained at a temperature of 950 ± 20°C, and lower immediately to the 950 zone.

7.2 After the more rapid discharge of volatile matter has subsided as shown by the disappearance of the luminous flame, inspect the crucible to verify the lid is still properly seated. If necessary, reseat the lid to guard against the admission of air into the crucible. Do this as rapidly as possible by raising the crucible to the top of the furnace chamber, reposition the lid to more perfectly seal the crucible, then lower immediately back to the 950 zone.

7.3 After heating for a total of exactly 7 min, remove the crucible from the furnace and, without disturbing the cover, allow it to cool. Weigh as soon as cold. The percentage loss of weight minus the percentage moisture equals the volatile matter.

8.0 Calculations

Weight loss, % = (A-B)/A x 100
where A = weight of sample used, g,
B = weight of sample after heating, g

Volatile matter in analysis sample, % = C-D
where C = weight loss, %
D = moisture, %

9.0 Precision

Duplicate results by the same laboratory should not be considered suspect unless they differ by more than the following percentages:

Anthracite	0.3
Semianthracite, bituminous low-temperature coke and chars	0.5
Subbituminous	0.7
Lignite and peat	1.0

10.0 Reference

1. A.S.T.M; D-3175

NB POWER

CHEMICAL LABORATORY PROCEDURE

FIXED CARBON IN THE ANALYSIS SAMPLE OF COAL

1.0 Theoretical Background

The fixed carbon is a calculated value. It is the result of the summation of percentage moisture, ash and volatile matter subtracted from 100. All percentages shall be on the same moisture reference base.

2.0 Outline of Method

The tests for moisture, ash and volatile matter are performed and the percentages calculated. From these values, fixed carbon is determined.

3.0 Interferences

None.

4.0 Apparatus

None.

5.0 Precautions

None.

6.0 Reagents

None.

7.0 Procedure

None.

8.0 Calculations

% Fixed carbon = 100 - (% moisture + % ash + % volatile matter)

9.0 Precision

The precision of this test is dependent on the type of coal used and on the precision of the moisture, ash and volatile matter tests.

10.0 Reference

1. A.S.T.M; D-3172-73

NB POWER

CHEMICAL LABORATORY PROCEDURE

GROSS CALORIFIC VALUE OF SOLID FUEL

BY THE ISOTHERMAL-JACKET BOMB CALORIMETER

1.0 Theoretical Background

This method covers determination of the gross calorific value of solid fuel by the isothermal-jacket bomb calorimeter.

2.0 Outline of Method

Calorific value is determined in this method by burning a weighed sample in oxygen in a calibrated isothermal-jacket bomb calorimeter under controlled conditions. The calorimeter is standardized by burning benzoic acid. The calorific value of the sample is computed from temperature observations made before, during, and after combustion, and making proper allowance for heat contributed by other processes.

3.0 Interferences

None.

4.0 Apparatus

4.1 Test room, free from drafts and which can be kept at a reasonably uniform temperature for the time required

for the determination. The apparatus should be shielded from direct sunlight and radiation from other sources. Thermostatic control of room temperature and controlled relative humidity are desirable.

4.2 Combustion Bomb, constructed of materials that are not affected by the combustion process or products sufficiently to introduce measurable heat input or alteration of endpoints. The bomb must be designed so that all liquid combustion products can be completely recovered by washing the inner surfaces. There must be no gas leakage during the test. The bomb must be capable of withstanding a hydrostatic pressure test to a gauge pressure of 3000 psi (approximately 20 MPa) at room temperature without stressing any part beyond its elastic limit.

4.3 Calorimeter, made of metal with a tarnish-resistant coating, and with all outer surfaces highly polished. Its size should be such that the bomb will be completely immersed in water when the calorimeter is assembled. It should have a device for stirring the water thoroughly and at a uniform rate, but with a minimum heat input. Continuous stirring for ten minutes should not raise the calorimeter temperature more than 0.01°C starting with identical temperatures in the calorimeter, room, and jacket. The immersed portion of the stirrer should be coupled to the outside through a material of low heat conductivity.

4.4 Jacket - The calorimeter should be completely enclosed within an isothermal stirred-water jacket, from which it should be insulated by an air space. Mechanical supports should provide as little thermal conduction as possible. To minimize convection currents, the air space should be approximately 10

mm wide, uniformly over the surface. The water jacket should be provided with a means of keeping its temperature constant to within 0.1°C at a temperature 2°C or more above room temperature throughout the determination.

4.5 Thermometer

4.6 Crucibles, open, of platinum, quartz, or acceptable base metal alloy. Base metal alloy crucibles are acceptable if after a few preliminary firings the weight does not change significantly between tests.

4.7 Firing Wire, 100 mm of No. 34 B & S gauge (0.16 mm diameter) nickel-chromium alloy wire. Platinum wire No. 38 B & S gauge (0.10 mm diameter) may be used provided constant ignition energy is supplied. The lengths of the firing wire should remain constant for all calibrations and calorific value determinations.

4.8 Firing circuit - A 6 to 16-V alternating or direct current is required for ignition purposes with an ammeter or pilot light in the circuit to indicate when current is flowing. A step-down transformer connected to an alternating current lighting circuit or batteries may be used. The ignition circuit switch should be of the momentary double-contact type, normally open, except when held closed by the operator. The switch should be depressed only long enough to fire the charge.

5.0 Precautions

5.1 The weight of coal sample and the pressure of the oxygen admitted to the bomb must not exceed the bomb manufacturer's recommendations.

5.2 Bomb parts should be inspected carefully after each use. Threads on the main closure should be checked

frequently for wear. Cracked or significantly worn parts should be replaced. The bomb should be returned to the manufacturer occasionally for inspection and possibly proof firing.

5.3 The oxygen supply cylinder should be equipped with an approved type of safety device, such as a reducing valve, in addition to the needle valve and pressure gauge used in regulating the oxygen feed to the bomb. Valves, gauges, and gaskets must meet industry safety code. Suitable reducing valves and adaptors for 300 to 500 psi (2070 to 3440 KPa) discharge pressure are obtainable from commercial sources of compressed gas equipment. The pressure gauge shall be checked periodically for accuracy.

5.4 During ignition of a sample, the operator must not permit any portion of his body to extend over the calorimeter.

5.5 Extreme caution must be exercised when combustion aids are employed so as not to exceed the bomb manufacturer's recommendations and to avoid damage to the bomb. Do not fire loose fluffy material such as unpelleted benzoic acid, unless thoroughly mixed with the sample.

5.6 Admit oxygen slowly into the bomb so as not to blow powdered material from the crucible.

5.7 Do not fire the bomb if it has been filled to greater than 30 atm (3 MPa) pressure with oxygen, the bomb has been dropped or turned over after loading, or there is evidence of a gas leak when the bomb is submerged in the calorimeter water.

5.8 Make checks on the energy equivalent after changing the oxygen supply, after changing any part of the calorimeter, and at least once a month otherwise. Make the test procedure for checking the energy

equivalent in the same manner as a routine fuel sample except determine a required number of individual tests as follows:

5.8.1 If a single new determination differs from the old value by 0.14%, the old value is suspect, thereby requiring a second test.

5.8.2 The difference between the two new determinations must not exceed 0.18%, and the average of the two new determinations must not differ from the old value by more than 0.1%. If these requirements are met, do not change the energy equivalent of the calorimeter.

5.8.3 If the requirements given in 5.8.2 are not met, two more tests must be made. The range of the four new determinations must not exceed 0.32%, and the average of the four new determinations must not differ from the old value by more than 0.07%. If these requirements are met, do not change the energy equivalent of the calorimeter.

5.8.4 If the requirements given in 5.8.3 are not met, a fifth and sixth determination must be made. The range of the six new determinations must not exceed 0.39% and the average of the six new determinations must not differ from the old value by more than 0.05%. If these requirements are met, do not change the energy equivalent of the calorimeter.

5.8.5 If the requirements given in 5.8.4 are not met, four more determinations must be made to complete a series of ten tests. The range of these ten determinations must not exceed 0.45% and the average of the ten new determinations must not differ from the old value by more than 0.03%. If these requirements are met, do not change the energy equivalent of the calorimeter.

5.6.6 If the requirements given in 5.8.5 are not met, the average value from the ten new determinations must be used for the new energy equivalent, provided that the standard deviation of the new series does not exceed 0.15%.

6.0 Reagents

6.1 Benzoic Acid, Standard (C_6H_5-COOH) - Use pellets made from National Bureau of Standards benzoic acid.

6.2 Methyl Orange, Methyl Red, or Methyl Purple Indicator, may be used to titrate the acid formed in the combustion.

6.3 Oxygen, free of combustible matter. Only oxygen manufactured from liquid air, guaranteed to be greater than 99.5% pure, should be used.

6.4 Titrating Solution - Use an appropriate amount of anhydrous sodium carbonate (Na_2CO_3) reagent grade or equivalent. The burette used for the nitric acid titration should be of such an accuracy that estimation to 0.1 ml can be made.

NOTE: A convenient concentration of Na_2CO_3 is 0.294 N (20.90 g Na_2CO_3/1000 ml) which simplifies the calculation of the correction for nitric acid formation.

7.0 Procedure

7.1 Standardization of the Calorimeter

7.1.1 Determine the energy equivalent of the calorimeter for a specific temperature rise as the average of a series of ten individual runs made over a period of not less than 3 days nor more than 5 days. To be acceptable, the standard deviation of the series should be 0.15% or less. For this purpose, any individual test

may be discarded only if there is evidence indicating incomplete combustion. If this limit is not met, the entire series should be repeated until a series is obtained with a standard deviation below the acceptable limit.

7.1.2 The calorimeter is standardized by combustion of benzoic acid. Regulate the weights of the pellets of benzoic acid in each series to yield the same temperature rise as that obtained with the coals tested in the same laboratory. The usual range of weights is 0.9 to 1.3 g. Weigh the pellet to the nearest 0.0001 g in the sample holder in which it is to be burned, and record the weight.

7.1.3 Rinse the bomb, invert momentarily, and leave undried. Approximately 1 ml of water should remain in the bomb.

7.1.4 Connect a measured length of firing wire to the ignition terminals, with enough slack to allow the firing wire to maintain contact with the sample.

7.1.5 Assemble the bomb in the normal manner and charge it with oxygen to a consistent pressure between 20 and 30 atm (2 to 3 MPa). This pressure must remain the same for each calibration and each calorific value determination. If the oxygen should exceed the specified pressure, do not proceed with the combustion. In this case, detach the filling connection and exhaust the bomb in the usual manner and discard this sample.

7.1.6 Adjust the calorimeter water temperature to 1.0 to 2.0°C below jacket temperature but not lower than 20°C. Use the same weight, measured to ± 0.5 g, of water in each test. For 2000 ml calorimeters, the proper quantity can be obtained by use of a volumetric flask calibrated to de-

liver 200 ± 0.5 ml. As the density of water varies with temperature, make suitable corrections if the water temperature varies from the temperature at which the flask was calibrated. Place the assembled bomb in calorimeter, connect electrode contact, and add measured calorimeter water.

7.1.7 Transfer the bomb to the water jacket, finish assembly of the apparatus, and start the stirrer. Allow 5 minutes for attainment of equilibrium; then record the calorimeter temperature at 1-minute intervals for 5 minutes or until the rate of change has been nearly constant for 5 minutes. Fire the charge at the start of the sixth interval and record the time, a, and the thermometer reading, t_a. Take the next two readings 0.5 minutes and 1 minute after firing because of the rapid rise. Record subsequent readings at 1 minute intervals on the minute until the difference between successive readings has been constant for 5 minutes. If the final temperature is above the bath temperature, the temperature rises to a maximum and then begins to fall. The time, c, and the thermometer reading, t_c, are the first readings after the rate of change has become uniform.

7.1.8 Remove the bomb and release the pressure at a uniform rate, such that the operation will require not less than one minute. Examine the bomb interior and discard the test if unburned sample or sooty deposits are found. Wash the interior of the bomb with distilled water containing the titration indicator, until the washings are free of acid, and titrate the washings with standard carbonate solution. Remove and measure or weigh the combined pieces of unburned

firing wire and subtract from the original length or weight to determine the wire consumed in firing. See Calculations for the corrected temperature rise, t, corrections for HNO_3, e_1, and firing wire, e_3, and energy equivalent, W.

7.2 Procedure for Solid Fuel Samples

7.2.1 Obtain the calorific value determination by burning a weighed sample of the fuel in the standardized calorimeter, and observing the temperature rise of the calorimeter. Obtain the corrected temperature rise caused by combustion by applying proper thermometer and radiation corrections to the observed temperature rise. The result multiplied by the energy equivalent gives the total heat developed, which, when adjusted for side reactions, gives the energy of combustion of the fuel.

7.2.2 Weigh approximately 1 g of coal to the nearest 0.1 mg. The sample should be the material pulverized to pass No. 60 (250-μm) sieve and well-mixed. A separate portion of the analysis sample should be analyzed for moisture content.

7.2.3 Prepare the bomb and calorimeter as described in Sections 7.1.3 through 7.1.6.

7.2.4 Transfer the calorimeter to the water jacket, finish assembly of the apparatus, start the stirrer, and adjust the temperature of the calorimeter to the desired starting temperature. Allow 5 minutes for the attainment of steady state. Fire charge and record the time and thermometer reading t_a. Exactly c-a minutes later (± 2 s) obtain final thermometer reading t_c (see 7.1.7). Alternatively, a test sample may be run using the same procedure as for standardization with benzoic acid (7.1.1 to 7.1.8).

8.0 Calculations

Corrected temperature rise, t:

$$t = t_c - t_a + C_e + C_s + C_r$$

where C_e = emergent stem correction if required

C_s = setting correction if required

C_r = radiation correction

t_a = corrected thermometer reading at time of firing

t_c = corrected final thermometer reading.

NOTE: All mercury-in-glass thermometers must be corrected for scale error, using data from the thermometer certificate. Beckman thermometers also require a setting correction and an emergent stem correction. Solid stem ASTM Thermometers 56C and 56F do not require emergent stem corrections if all tests, including standardization, are performed within the same 5.5°C interval. If operating temperatures range beyond this limit, a differential emergent stem correction must be applied to the corrected temperatrue rise, t, in all tests, including standardization.

Compute the corrections for HNO_3, e_1, and firing wire, e_3, using the factors listed in Table 1 below.

Table 1 Thermochemical Correction Factors

Correction	Multiplication Factor	Multiply By
e_1 (HNO_3)	10.0	ml of 0.394N Na_2CO_3 solution
e_2 (H_2SO_4)	23.7	percent sulphur in sample times weight of sample in grams
e_3 (fuse wire)	0.41	length (mm) of No. 34 B & S gauge Chromel C wire
e_3 (fuse wire)	2.6	weight (mg) of Chromel C wire.

NOTE: There is no correction for platinum wire provided the ignition energy and the weight of wire are constant.

Energy equivalent, W:

$$W = (H \times g + e_1 + e_3)t$$

where W = energy equivalent, (BTU/lb)x(g/deg)

H = energy of combustion of benzoic acid, as stated in the National bureau of Standards Certificate, Btu/lb in air

g = weight in air of benzoic acid, g

e_1 = correction for energy of formation of HNO_3, or titration correction

e_3 = correction for energy of combustion of fuse wire

t = corrected temperature rise.

Gross Calorific Value, Q_v (gross):

$$Q_v \text{ (gross)} = [(t)(W) - e_1 - e_2 - e_3]/g$$

where Q_v (gross) = gross calorific value, Btu/lb,

t = corrected temperature rise as calculated above

W = energy equivalent of calorimeter as calculated above

e_1 = correctibn for energy of formation of HNO_3

e_2 = correction for energy of formation of H_2SO_4

e_3 = correction for energy of combustion of fuse wire

g = weight of sample, g

Net Calorific Value, Q_p (net):

$$Q_p \text{ (net)} = Q_v \text{ (gross)} - 10.30 (H \times 9)$$

where Q_p (net) = net calorific value, Btu/lb

Q_v (gross) = gross calorific value, Btu/lb

H = total hydrogen, %

9.0 Precision

Duplicate results by the same laboratory on different days, using the same operator and equipment, should not be considered suspect unless they differ by more than 50 Btu/lb.

APPENDIX F

SECTION F.6

NB POWER

CHEMICAL LABORATORY PROCEDURE

TOTAL SULPHUR IN THE ANALYSIS

SAMPLE OF COAL

1.0 Theoretical Background

This method covers the determination of total sulphur in samples of coal.

2.0 Outline of Method

Sulphur is precipitated as $BaSO_4$ from oxygen-bomb calorimeter washings, and the precipitate is filtered, ashed, and weighed.

3.0 Interferences

None.

4.0 Apparatus

4.1 Oxygen-bomb calorimeter from calorific determination.

4.2 Crucibles or capsules - porcelain, 22 mm in depth and 44 mm in diameter, or porcelain crucibles of 30 ml capacity, high or low form. Porcelain, platinum, alundum, or silica crucibles of 10 to 15 ml capacity shall be used for igniting the $BaSO_4$.

4.3 250 ml beaker

4.4 Gas or Electric Muffle Furnace or Burners, for igniting the barium sulphate.
NOTE: Gas may contain sulphur compounds.

4.5 Qualitative Filter Paper

4.6 Pipette

5.0 Precautions

None.

6.0 Reagents

6.1 Ammonium Hydroxide - concentrated.

6.2 Bromine Water (Saturated) - Add an excess of bromine to one litre of water.

6.3 Hydrochloric Acid (1 + 1) - Mix equal volumes of concentrated hydrochloric acid and water.

6.4 Sodium Carbonate Solution - Dissolve 20.90 g of anhydrous sodium carbonate (Na_2CO_3) in water and dilute to one litre. The Na_2CO_3 should be previously dried for 24 hours at 105°C.

6.5 Wash Solution - Dilute one ml of a saturated solution of methyl orange to one litre with water.

6.6 Hydrochloric Acid (1 + 9) - Mix one volume of concentrated HCl with 9 volumes of water.

6.7 Sodium Hydroxide Solution (100 g/litre) - Dissolve 100 g of sodium hydroxide (NaOH) in one litre of water. This solution may be used in place of the Na_2CO_3 solution.

6.8 Barium Chloride Solution (100 g/litre) - Dissolve 100 g of barium chloride ($BaCl_2 \cdot 2H_2O$) and dilute to one litre with water.

7.0 Procedure

7.1 Sulphur is determined in the washings from the oxygen-bomb calorimeter following the calorimetric determination. The type of bomb, amount of water in the bomb, oxygen pressure, and amount of sample taken should be the same as specified under the calorimetric determination. The bomb shall stand in the calorimeter water for not less than 5 minutes after firing.

7.2 Sulphur sample should be the material pulverized to pass No. 60 (250 µm) sieve. A separate portion of the analysis sample should be analyzed for moisture content.

7.3 Remove the bomb from the calorimeter water and open the valve carefully so as to allow the gases to escape at an approximately even rate so the pressure is reduced to atmospheric in not less than one minute. Bombs equipped with valves other than needle valves shall be provided with a device so the valve can be controlled to permit a slow and uniform release of the gases.

7.4 Open the bomb and examine the inside for traces of unburned material or sooty deposit. If these are found, discard the determination.

7.5 Wash carefully all parts of the interior of the bomb, including the capsule, with a fine jet of water containing methyl orange until no acid reaction is observed. It is essential to wash through the valve opening in the case of bombs equipped with compression valves, or other types of valves with large openings, as considerable spray may collect in such valve openings.

7.6 Collect the washings in a 250 ml beaker and titrate with standard sodium carbonate solution to obtain the "acid correction" for the heating value, as

specified under the calorimetric determination.

7.7 Adjust the pH to 5.5 to 7.0 with dilute NH_4OH, heat the solution to boiling, and filter through a qualitative paper. Wash the residue and paper thoroughly five or six times with hot water.

7.8 To the filtrate and washings, amounting to about 250 ml, add 1 ml of saturated bromine water and sufficient HCl to make it slightly acid. Boil the solution to expel the excess bromine.

7.9 Make just neutral to methyl orange with Na_2CO_3 or NaOH solution; then add 1 ml of HCl (1 + 9). Boil again and add slowly from a pipette, while stirring constantly, 10 ml or more of $BaCl_2$ solution. The $BaCl_2$ solution must be in excess. If more than 10 ml of $BaCl_2$ solution is required, reduce the weight of sample to about 0.5 g and repeat ignition and digestion.

7.10 Continue boiling for 15 minutes and allow to stand for at least two hours, or preferably overnight, at a temperature just below boiling.

7.11 Filter through an ashless paper and wash with hot water until one drop of silver nitrate ($AgNO_3$) solution produces no more than a slight opalescence when added to 8 to 10 ml of filtrate.

7.12 Place the wet filter containing the precipitate of barium sulphate in a weighed platinum, porcelain, silica, or alundum crucible, allowing a free access of air by folding the paper over the precipitate loosely to prevent spattering. Smoke the paper off gradually and at no time allow to burn with flame. After the paper is practically consumed, raise the temperature to approximately 925°C and heat to constant weight.

7.13 In all cases, a correction must be applied. Either

a reagent blank may be run exactly as described above, using the same amount of all reagents that were employed in the routine determination, or a more accurate correction may be made by analyzing a weighed portion of a standard sulphate using the prescribed reagents and operations. If the latter procedure is carried out once a week, or whenever a new supply of a reagent is used, for a series of solutions covering the approximate range of sulphur concentrations in the samples, it is only necessary to add to or subtract from the weight of $BaSO_4$ determined for the sample, the deficiency or excess found by the appropriate "check" determination. This procedure is more accurate than the simple reagent blank because, for the amount of sulphur in question and the conditions of the precipitation prescribed, the solubility error for $BaSO_4$ is probably the largest one to be considered.

8.0 Calculations

Sulphur, %, in the analysis sample,

$$= \frac{(A-B) \times 13.738}{C}$$

where A = grams of $BaSO_4$ precipitated
B = grams of $BaSO_4$ correction
C = grams of sample used.

9.0 Precision

Results of two consecutive determinations carried out on the same sample in the same laboratory by the same operator using the same apparatus should not differ more than 0.10%, for coal containing 2% sulphur or more.

10.0 References

1. ASTM: D-3177, Method B.

APPENDIX F

SECTION F-7

VISCOSITY TEST PROCEDURE

FOR COAL-WATER FUELS (C.W.F.)

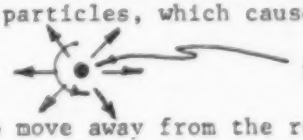
EQUIPMENT USED:- "Brookfield Viscosity Meter with a number 4 spindle.

DISCUSSION: - C.W.F., is a slurry containing; coal (of different partiel sizes) chemical additives, and water.

- Viscosity; is a measure of the slurry's resistance to internal deformation (or shear).

- Shear; internal deformation.

CONCLUSION: - As the spindle (of Brookfiels Meter) rotates in the C.W.F. slurry it imparts a centrifugal force on the coal particles, which causes



these particles to move away from the rotating spindle.

- After a short time a crust forms on top of the C.W.F. slurry preventing the particle from moving away from the spindle.

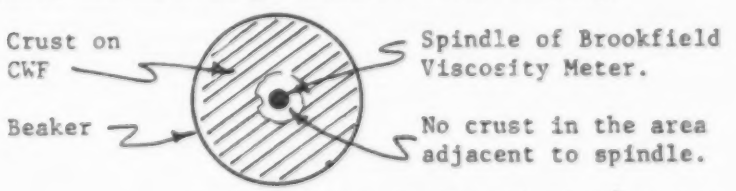
- Due to the movement of the spindle the crust does not form adjacent to it.

- It was observed that the viscosity reading stabilized after the crust had formed.

- The moisture readings changed very little, so it was assumed this had no effect on the viscosity reading.

- From this experiment it was concluded that all the viscosity readings would be taken after the meter had been running for five minutes, and then three readings would be taken, 30 seconds apart, and an average taken of these readings.

DIAGRAM OF EQUIPMENT:



Prepared By: Chatham Plant Laboratory

APPENDIX F

SECTION F.8

DETERMINATION OF % COMBUSTIBLE (UNBURNT CARBON) IN ASH

The purpose of this procedure is to determine how much of a combustible material is left in boiler slag or ash.

Fly ash samples were obtained through the use of a "CEGRIT". Bottom ash was manually scraped from the bottom of the furnace.

PROCEDURE:

1. Crush the sample so that it will pass through a 15 mesh screen. Perform this task as quickly as possible so as to lose as little moisture as possible.

2. Dry the sample at a temperature of 110°C for five (5) hours.

3. From the dried sample, obtain a representative sample of 50 gms.

4. Grind this sample so it will pass through a 60 mesh screen.

5. From this sample, obtain a one (1) gram representative sample.

6. Dry this sample at 110°C for two (2) hours.

7. The percent moisture was then determined.

8. The sample is then placed in an electric furnace at 900°C for one (1) hour.

9. Remove the sample, cool, and reweigh.

10. From the following formula, the % combustible may be determined:

$$\% \text{ combustible} = \frac{\text{ignition loss}}{\text{wt.of ash} - \text{wt.of moisture}} \times 10$$

NOTE: Weight of ash = 1 gm.

OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

APPENDIX G

TEST EQUIPMENT USED

EQUIPMENT

The following is a list of additional pieces of equipment required to conduct the test:

1) A portable diesel driven air compressor delivering 800 cfm of oil free air at 250 psi, was provided, on rental, through Combustion Engineering.

2) A portable Zeigler Opacity Meter provided through N.B.Power's Plant Technical Services group.

3) A micro-motion meter for measuring fuel flow provided by Combustion Engineering free of charge.

4) A "Brookfield Viscosity Meter" with a No.4 spindle was used to measure fuel viscosity.

5) A "CEGRIT" was used to collect fly ash samples.

OXCE FUEL DEMONSTRATION

AT

N.B. POWER'S CHATHAM T.G. STATION

APPENDIX H

PURCHASE ORDERS

Transportation Contract for OX-CE Fuel

Rental of Air Compressor through C.E.

CWF 3-3.0

COMMANDE

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

515 RUE KING STREET, FREDERICTON, N.B., CANADA, E3B 4X1
TELEPHONE (506) 453-4444 TELEX 014-46194

SEE REVERSE SIDE FOR INVOICING AND SHIPPING INSTRUCTIONS
VOIR AU VERSO POUR LES INSTRUCTIONS RELATIVES À LA FACTURATION ET À L'EXPÉDITION

DATE: 85-06-12

PURCHASE ORDER NO. / N° DE COMMANDE: 060-~~5021~~ 6021

VENDOR NUMBER: 061989

SHIP TO/DESTINATAIRE:
THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

Chatham Generating Station
Chatham, NB

TO/À

OXCE Fuel Company
1000 Prospect Hill Road
Winsor, Connecicut
U.S.A. 06095

AT/Donald MacDonald FOR / POUR K.C. Brown

FOB POINT/POINT FAB	DELIVERY/LIVRAISON	SHIP VIA/EXPÉDIER PAR	TERMS/ÉCHÉANCE
Delivered	8 Weeks		Net 30 Days

	OXCE Demonstration #3 Material List No. 671-1000A			
1	Transportation costs of 1,020,000 pounds of coal water fuel from their Jacksonville, Florida Plant to be the Chatham Thermal Generating Station in Chatham, NB. The fuel is to be shipped by six rail tank cars. Cost is to include car cleaning and empty car mileage costs.		Lot	$32,905.00/Lot US Fund
2	Rail car rental		3 Cars	$ 315.00/car per mont
3	Remaining three (3) cars will be free of charge for two months commencing with loading.		3 Cars	No Charge for first two month
4	Thr three cars of item 3 commencing 3rd month and terminating when the empty cars are returned to Jacksonville.		3 Cars	$ 765.00/car per mont

.../2

STR	CAP	SUB	COM	AMOUNT
010	3	44	2	

ITEMS	ACCOUNTING DISTRIBUTION MAIN	SUB	COST CENTER	SOURCE CENTER	COST CONTROL ASSET/COMP	TRACKING
	671	103	44000	44000		E00603

THIS ORDER IS SUBJECT TO ALL TERMS AND CONDITIONS SHOWN ON THE FACE AND REVERSE SIDE HEREOF AND IS NOT SUBJECT TO CHANGE OR MODIFICATION WITHOUT THE PRIOR WRITTEN CONSENT OF THE BUYER.
LA PRÉSENTE COMMANDE DOIT SE CONFORMER À TOUTES LES MODALITÉS INDIQUÉES SUR CETTE PAGE ET AU VERSO ET NE DOIT PAS ÊTRE CHANGÉE OU MODIFIÉE SANS OBTENTION AUPARAVANT L'APPROBATION ÉCRITE DE L'ACHETEUR

AUTHORIZED / AUTORISÉE _____ BUYER-ACHETEUR _____ DIR. OF PURCHASING-DIR. DES ACHATS

BUYER / ACHETEUR C.F. Edgecombe II 453-4248 TELEPHONE

EXPEDITER C.F. Bell 453-3169 TELEPHONE

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

527 RUE KING STREET, FREDERICTON, N.B., CANADA, E3B 4X1
TÉLÉPHONE (506)453-4444 TELEX 014-46194

SHIPPING ADDRESS TERMS AND CONDITIONS ARE AS NOTED ON PAGE ONE
L'ADRESSE D'EXPÉDITION ET LES MODALITÉS SONT MENTIONNÉES À LA PREMIÈRE PAGE

DATE	PURCHASE ORDER NO. / Nº DE COMMANDE
85-06-12	6021 060-5091

ORDER CHANGE NO. / Nº DE LA MODIFICATION DE COMM.	PAGE NUMBER / NO. DE PAGE
	2 OF / DE 2

TO/À:

OXCE Fuel Company

ITEM / ARTICLE	DESCRIPTION		QTY	QUANTITY / QUANTITÉ	TAX / TAXE	PRICE / PRIX
	As part of this contract OXCE Fuel Company is to supply the following minimum information on the fuel in each car: High Heat Value - MJ/Kg % Ash % Volatile matter Specific Gravity % Moisture % of particles passing 48 mesh Viscosity at 75 sec. Viscosity after 24 hr. Viscosity vs shear Differential Change All the above is as per OXCE Fuel Company's proposal No. 03584F and confirming telex to D.M. Rankin from Greg Dubien dated May 22, 1985. The supplier is responsible for expediting cars to and from the Canadian border and will provide expediting reports to NB Power's Myles Williams at (506) 453-4491					

N.B. POWER
FORM 263 1985-04
M & S 832-040

PURCHASE REQUISITION
(REGULAR)

REQUISITION NUMBER: location 060 | serial 2051

PURPOSE OR USE: Chatham G.S. OXCE Demo Project

WHEN RECEIVED ADVISE: K.C. Brown

DELIVER TO: Water Street | Chatham, N.B. | Donald MacDonald

(STREET AND NO | CITY OR TOWN | ATTENTION)

ITEM	ITEM DESCRIPTION	STOCK CODE NO.	QUANTITY	PRICE
01	Rental of an air compressor supplied by KDL			
	of Windsor, Connecticut, USA for use on the			
	OXCE Demonstration Project at the Chatham			
	Generation Station.			
	This order is to cover the period commencing			
	July 29/85 and ending October 1/85.			
	Rental cost is $12,000.00/Mo. (US Funds).			
	DELIVERY - already on site.			
	It is understood that CES resumes respons-			
	ibility for rental costs within four (4)			
	days of official notification from NB Power			
	that Unit No. 2 is ready for the test of			
	OXCE fuel.			
	REFER TO ATTACHMENTS 1, 2, 3.			

ITEMS	ACCOUNTING DISTRIB'N. Main	Sub	Cost Centre	COST CONTROL Source Centre	Asset/Comp	Tracking	AMOUNT	SUPPLIER AND ADDRESS
	671	209	44000					Combustion Engineering
								Superheater Canada Ltd.
								Ottawa, Ontario
								Attention: G.D. Gregorio

NUMBER:

PURCHASING DEPARTMENT USE ONLY

PROVINCIAL SALES TAX	Items	FEDERAL SALES TAX	Items		Items	BUYER CODE
0 EXEMPT		A R.O.A.		E FUEL OIL		EXPEDITER CODE
8 EXTRA		B I.I.I & LIC.		F N/A		SUPP. & MAN. CODE
I INCLUDED		C I.I.I & SEC. 2		G TAXABLE 10%		
AMOUNT SUBJECT	$	D I.I.I SEC. 1,3,4		H TAXABLE 06%		COMMODITY CODE
				I INCLUDED		

TERMS AND CONDITIONS OF SALE

F.O.B.	DELIVERY VIA	F.S.T.	TERMS OF PAYMENT
N.A.	N.A.	☐ INCLUDED ☐ NOT INCLUDED	Net 30 Days

REQUESTED BY	DATE	APPROVED-BR. PLANT OR DEPT. HEAD	DATE	APPROVED-DIVISION MANAGER	DATE
1 D.M. KAHAN	[illegible]	2		3	
CLEARED-GENERAL STORES	DATE	PURCHASE ORDER AUTHORIZED	DATE	FINALIZED-PURCHASING	DATE
4		5		6	